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EDITORIAL

THE RISE OF THE SURGICAL MOTION PICTURE

IN spite of the policy of the various medical societies and groups to feature outstanding speakers and vital subjects at their sessions, the most liberally attended programs seem to be those where motion pictures are shown. Indeed, at the larger meetings, instead of one hall featuring a general run of surgical pictures, now three to five separate projection rooms are set up with all day programs of specialties which play to crowded houses. With the advent of color duplication in 16 mm. films and successful 16 mm. sound track on film, we are forced to pay definite attention to the future of the surgical motion picture.

The first motion picture of surgical operations on record at the American College of Surgeons is one of a cesarean section performed by Dr. Robert Fitz-Patrick in 1915. This was followed by many animated films depicting surgical technique, one of which, Kanavel's hand picture, is still a classic. In 1925 early surgical color films using the revolving wheel principle were shown in New York by Cherry and Sheehan and later a chemical process color-sound surgical film was made in Hollywood in magnacolor. Motion pictures of fluoroscopy were made first by Stewart of New York and Kawaishi of Japan in 1938. The use of the translucent screen for the showing of several slides or films simultaneously was brought out in 1939.

Realizing the importance of surgical motion pictures to audiences of mixed nationalities, the Pan-Pacific Surgical Congress at Honolulu in 1939 requested members presenting papers to illustrate them with motion pictures if possible. Special arrangements were made to preview films and aid in editing and cutting. The Association furthermore sponsored the making by me of a 1200 foot color-sound 16 mm. film on "The Making of a Surgical Motion Picture" and premiered it at the meeting. Prints of this film are now being shown in Australia and New Zealand under the auspicies of the Royal Australasian College of Surgeons through the courtesy of Dr. Robert Godsall of Sydney.

It is estimated that there are over one thousand medical and surgical pictures in the United States today. Many of them are outdated or are on early color film which has now faded badly. The American College of Surgeons has an approved list of films and an exchange service for members but owns no surgical films for loan purposes. Mr. C. Carroll Adams of Davis and Geck, Inc., has built up a good library of both black and white and color films for loan to meetings, medical societies, etc. Several other companies have smaller collections of films which are available for rental or loan.

During the past twelve months the duplication of 16 mm. color film has be-

come a successful commercial venture and the reduction of 35 mm. color to 16 mm. color has also been accomplished. Sound track may now be added to 16 mm. color duplicate prints, removing the last objection to the general making of surgical movies, as the sound track can be printed on the film after it has been cut and edited.

The average charge today of the semi-professional concerns in the larger cities making surgical films, is entirely too high and is based on the premise that the surgeon knows little or nothing of how to make a picture. However, instruction is available only by this means.

If someone were to specify, in making a bequest for the advancement of surgery, that a sum be set aside for research and help for men interested in making surgical pictures, a great good would ensue. From this, annual awards for the best films, the establishment of a general review board and a national surgical film exchange, would be natural growths. Special surgical television broadcasts are distinct possibilities for the future.

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It has been called to our attention that an article on "Surface Defects of the Hand" by Dr. James Barrett Brown, published in our Emergency Surgery Symposium (December, 1939) was in large part quoted from a previous article of Dr. Brown's, published in "Annals of Surgery," June, 1938 (J. B. Lippincott and Company, Publishers). As stated in our General Information to Contributors, "Articles are accepted for publication with the understanding that they are original contributions never previously published." This was our understanding in the present case. We deeply regret that a footnote of Dr. Brown's calling attention to the matter was unnoticed, and we present this explanation to our readers and to the J. B. Lippincott Company.

T. S. W.

ORIGINAL ARTICLES

THE USE OF LOCAL ANESTHESIA IN GENERAL SURGERY*

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MY first observations of operations performed with local anesthesia, chiefly hernia operations, were made during my undergraduate days. Anesthesia then consisted of desensitizing the skin, but the patient had to bear the remaining pain. As a consequence, all the patients declared that *every* phase of the operation had been most painful. There were some surgeons who operated without any anesthesia at all, since, in their opinion, the wound would surely become painful after the effect of the anesthesia had worn off. They considered that it would be the same to the patient whether the ache was one-half hour or longer.

In 1904, as a young intern, I was able to observe good anesthesia, as obtained by Hütl, who employed a 1 per cent cocaine solution for minor operations. However, one of the patients died after an injection of 10 cg. of cocaine and this incident did not encourage us to undertake major operations with cocaine anesthesia.

At the same time we made a trial of Bier's lumbar anesthesia. The admirable success of the 100 cases carried out would have fixed my attention upon this procedure, if publications had not reported a mortality rate of one in 300 to 500 cases and if I had not seen the extreme postoperative suffering of the patients. Almost 30 per cent of all those operated upon developed severe headaches; in one instance I found transitory bladder palsy, in another case transitory palsy of the sciatic nerve developed.

I have made a life study of local anesthesia because of the improvement of anesthetic drugs; novocaine, tutocaine, and pontocaine. These are now applicable in larger amounts and are less toxic than cocaine, weak dilutions being effective, thus enabling their use in major operations. On the other hand, I have been deeply impressed by the horrible picture of oral operations done under general anesthesia.

Removal of buccal carcinoma, operations on the tongue or the upper and lower jaw, brought about anxiety, even if an artist, as was my first teacher Hütl, performed them. At that time we used chloroform, later we used ether. When the patient slept deeply, we were always fearful that he might be choked by inspiring blood. When he slept superficially or woke up, the assistant, who was dressed under sterile precautions, was unable to hold the head in the position required by the operating surgeon, in order to avoid additional injury while the cautery was being used in the open mouth.

In several instances previous tracheotomy had to be performed and the orifice of the larynx had to be packed off, in order to prevent blood from flowing into the lung. Notwithstanding this, many patients died of bronchopneumonia. The patient usually began to wake up just when a major artery was spurting, so that at the end of the operation the whole field was bloody.

After a visit to Bier's clinic in Berlin and to that of Reclus at the Hôtel Dieu, I began to be troubled again with these

* Read at a Post-Graduate Clinic Day at the Guthrie Clinic, Sayre, Pennsylvania, August 9, 1939.

questions. I could see that these horrible oral operations were transformed into uncomplicated, simple, short procedures when performed under local anesthesia, as the patient could coöperate by opening his mouth, stretching out his tongue and spitting out blood, if asked to do so.

Then I extended the field of application of local anesthesia; in 1909 I called attention to its use in abdominal operations (in *Orvosi Hetilap* and *Deutsche Zeitschrift für Chirurgie*). My present opinion is that there is no case which cannot safely be operated upon under local anesthesia. Our whole clinic is working according to this principle: general anesthesia is employed only if the procedure becomes more simple by its application, or if there is some special contraindication for local anesthesia.

The value of this method is, I think, fully illustrated by the following case: Once, when I was the professor's assistant at the Dollinger Clinic, I operated upon an old peasant, who did not utter a word during the whole operation, expecting we would anesthetize him before the procedure; when he was told that the operation was over, he would not believe it. At last he was shown his sewed wound and was asked whether he had suffered from pain. "Why, of course," he answered, "it *must* ache, if you cut a man."

Patients who have been lying in the hospital for one or two days and have watched those who have returned cheerful and relieved from the operating theater, would consider it a punishment if we attempted to anesthetize them before the operation.

I consider asepsis and anesthesia the two pillars of modern surgery. It is a well known fact that anesthesia originated in your country. (The dentist Morton and the surgeon Warren in Boston first employed ether in 1846, and the gynecologist Simpson in Edinburgh first used chloroform in 1844.) Asepsis, on the other hand, was conceived in the mind of Semmelweiss, the ingenious son of small Hungary.

Hippocrates said: "Divinum est opus sedare dolorem" (It is a divine task to relieve pain) but 2000 years later Velpeau declared that abolition of operative pain is such an absurd illusion that it should not be attempted, because there is scarcely one who has not yet suffered from it.

In common knowledge "pain" means almost the same as "disease." Pain aroused by a disease is watched most carefully by the physician, special consideration being given to its action upon the mind. Strümpell has characterized the term "pain" saying: "Pain is never caused by stimuli suitable for normal function of the organism, but it is due to some special stimulus, which disturbs the vital process of the organism and brings about such changes as never occur under physiological circumstances." We must emphasize in fact, that pain is a pathologic condition, no painful function being performed by the healthy organism. Operative pain is a highly pathologic and always a dreadful condition.

Formerly, we were almost helpless to control operative pain, as Guerin's example shows. In 1883, he proposed to burn the surroundings of the operative field by means of Viennese pasta. Dieffenbach reported a case in 1848 in which he has been unable to replace the bowels in the abdominal cavity until the patient had been made faint by letting blood from both his arms.

Though pain is undoubtedly a pathologic and dreadful condition, nevertheless it is important and is often considered a warning that the body or some organ of it is diseased. Every living being responds to changes of his bodily condition and reacts to influences that are exerted upon it by its environment. This function is fulfilled by the nervous system, which supplies all the body's members, connecting them with each other and which determines the relations between the organism and the surrounding world.

The nervous system consists of two parts: (1) the so-called autonomic (involuntary or visceral) nervous system

which regulates vital processes, as basal metabolism, blood circulation, breathing and sex functions; and (2) the central nervous system, consisting of the spinal medulla and of the brain, which brings the organism into connection with the outside world. These two parts of the nervous system form a whole, although acting differently. Certain parts of the nervous system mediate painful stimuli, others give origin to the sensation of pain.

The whole body or any part of it may be attacked by pain-causing stimuli. Inner organs may likewise undergo such painful alterations as to call the attention of the subject to the pathologic process. Pain may be started by mechanical insults, like gunshots, by cutting and stretching, by injuries caused by temperature or chemical agents or by galvanic and faradic currents. Lack of oxygen, as following arterial spasm, or vascular occlusion caused by a blood clot, may cause extreme degrees of pain.

There are receptors in almost every part of our body, picking up impulses, these being carried by sensitive fibers to the central nervous system. Each organ responds to a specific stimulus by causing the sensation of pain; thus an external hurt of the skin is painful, whereas the same injury is painless if applied to the bowel or the brain. Even the quality of pain arising from various tissues is different, since there are considerable differences in distribution and anatomy of the respective receptors.

Organs which are exposed to external influences, e.g., the skin, are more sensitive than those which are protected. There is furthermore a great difference between the sensitiveness of one individual and another; age, sex, place of residence and profession carry out a strong influence upon this matter. Northern people are more patient than southern ones; country people are more likely to suffer pain indulgently than townsfolk; intelligence and strength of mind are likewise helpful in bearing pain patiently.

Pain should not be considered as a merely useful condition, protecting the organism, because its warning signal is often absent when it is important, as in beginning cancer, and often it tortures the sick in vain, especially those who suffer from incurable diseases. I readily admit that spiritual treasures have often been brought to light by bodily suffering, that it teaches us better understanding of our fellowmen and that it may allow us to look into the depths of human life, but, as seen from the point of view of the physician, *the healthy organism is free of pain.* Although pain must be endured with patience, it can never be regarded as a fundamental principle of life. Alleviation or abolition of pain is one of the most beautiful tasks of the physician.

We can achieve anesthesia today in several ways: (1) by suspending irritability of receptors; (2) by interruption of carrying impulses at some spot of the nerve trunk; (3) by anesthetizing the spinal cord we can prevent painful impressions from reaching the brain; and (4) by paralyzing the cells or a special area of the brain we may impede the subjective sense of pain from being established.

The most grateful patients may be acquired by allaying pain, for most patients judge the gravity of their disease by the pain they have to suffer. Because this does not entirely cover the facts, we must never treat pain alone, but must attempt to cure the primary disease which gives rise to the painful sensations.

Surgeons have been disputing for years whether local or general anesthesia is preferable. In my opinion, these two methods are not to be compared to each other. Most surgeons operate under local anesthesia when the patient seems incapable of standing the operation under general. Others perform operations under local anesthesia only if this method is easier.

There is a fundamental difference between these procedures; (1) in operations performed under anesthesia, the surgeon depends completely upon the anesthetist;

(2) anesthesia is a procedure which runs independently from the surgical operation and may result in death in minor as well as in serious operations. Even if we are well aware of the fact that there is but one death of each 5,000 to 10,000 cases operated upon with general anesthesia, we do not feel perfectly secure.

In local anesthesia, we must first take into account that the more efficacious an anesthetic the greater is its toxicity. In the living organism, however, toxicity of many compounds is modified under the influence of certain factors.

The diffuse speed of an aqueous solution depends on the number of molecules contained in 1 liter of the solution and on their degree of dissociation. If aqueous solutions of two different salts are put on both sides of a permeable membrane, water is pushed through the membrane until both solutions are of the same concentration. There will be an exchange of both ions and molecules until the molecular and ionic conditions are the same on both sides.

It is a further well known fact that the freezing point of water is lowest when crystalloids are dissolved in it. Aqueous solutions of the same freezing point are called isosmotic. The freezing point of blood being −0.56°C., every solution that freezes at −0.56°C. is isosmotic with blood. These facts explain why injections of solutions that are isotonic with blood or tissue fluid are painless.

It must be emphasized that the absorption speed of a salt solution depends on the concentration of the solution. It is evident, however, that permeability of the tissues is a further factor in determining absorption of a certain solution. Loose adipose tissue is more permeable than thick fascia, periosteum or sheath of tendon. Absorption from the injected area will be fast or slow as to the value of local metabolism.

A chemical agent can have local effects only if it is retained in the tissue and does not enter the blood stream too quickly. The faster it enters the circulation, the more general will be its effects upon the organism. If the drug enters the circulating blood slowly, the central nervous system receives in each moment but a small amount of the highly diluted solution and so no untoward effects need be expected.

A very remarkable point of anesthesiology is the detoxifying action of tissues upon the anesthetic fluids which have remained within their network for some time before absorption.

What is required of a good anesthetic?

1. It must be a substance capable of paralyzing the nerve tissue at a low concentration, without being a protoplasm poison to the other tissues.

2. The anesthetic should possess a specific affinity to nerve tissue. Since, if it enters the circulation, it may seriously intoxicate the central nervous system, it ought to be retained at the site of injection as long as possible.

3. The change brought about in the sensory nerve by the anesthetic must cease after a certain time without leaving a trace.

4. The anesthetic must be transformed locally by the tissues in order to be released into the circulation in a detoxified state.

5. From a surgical point of view it is important that it be water-soluble, boilable and not liable to decomposition during sterilization. It must not irritate the tissues or cause pain on injection. It must be capable of being mixed with epinephrine in order to be retained locally.

The nerves supplying the individual organs are for the most part well known, but unless they are thoroughly understood, good anesthetization is impossible.

I have been studying the question of local anesthesia for nearly thirty years. At the Surgical Clinic of Professor Dollinger, in 1904, we performed 6,000 operations under local anesthesia—95 per cent of all cases, as reported by Professor Dollinger in 1913 at the International Congress of Surgeons in London. Together with my 1,200 cases operated upon at the Zita hospital, 7,200 operations were performed under procaine anesthesia; ¼ per cent

tutocaine was used in 6,675 cases; ½ per cent nupercaine in 4,420 cases; and recently pontocaine in 27,000. This makes a total of 45,295 major operations, and if I add our 41,744 operations performed upon outpatients, I can report 87,039 operations performed under local anesthesia without a single fatality during operation.

Methods have been amply commented upon in the works of Schleik, Braun, Reclus and Pauchet, I wish merely to call attention to some practical points.

The main cause of the change in anesthetics was the endeavor to use substances of the lowest possible concentration in order to depress the diffusion speed. In a major operation 180 or more c.c. of anesthetic solution is required. If a 1 per cent procaine solution is employed, this means not only the introduction of 1.5 to 1.8 Gm. of foreign substance into the organism, but also the use of a 1 per cent solution, the absorption of which, on account of its relatively high concentration, is more rapid than that of a 0.25 per cent solution (tutocaine), or of a 0.1 per cent solution (pontocaine). This will certainly increase the toxicity. That this is true, is evidenced by the fact that palpitation, pallor, diffuse sweating, rapid pulse and even nausea and vomiting during or shortly after anesthesia, were almost concomitant symptoms of 1 per cent procaine anesthesia, whereas with solutions of low concentration, the symptoms mentioned have become an extremely rare occurrence.

The anatomic site of the operation needs also careful consideration. On the head, neck or near the spinal column one cannot with impunity use as great quantities of an anesthetic as may be used far from the central nervous system, e.g., on the extremities. There the anesthetic must pass many more cells before reaching the central nervous system and in this way is more likely to be thoroughly modified or detoxified.

I would warn against injecting too great an amount at once; the dose should remain far below the toxic dose. If the patient should feel pain during the operation, the few milligrams of the anesthetic which will have been already detoxified, permit the injection of a considerable amount of additional anesthetic solution. This continuous supplemental dosage, according to need, makes it possible to complete under local anesthesia nearly every operation started under local anesthesia. My statistics show that only 1.9 per cent of operations begun under local anesthesia had to be completed under general anesthesia.

As to methods, I have returned to, and now use extensively the Schleich, Hackenbruch and Oberst methods with the adoption of certain modifications and all methods of nerve block anesthesia, trigeminal, and cervical that Kulenkampff, Keppler, Härtel, Läwen and others carried out endoneurally as well as perineurally. In the abdominal cavity I use the Braun anesthesia of the solar plexus, the celiac plexus, and the hypogastric plexus; infiltration of mesenteric attachments in operations on the intestine, and also parasacral anesthesia in bladder, prostate, vaginal and rectal operations. Paravertebral anesthesia I now use exclusively in kidney operations, injecting 20 c.c. of the anesthetic between the body of the twelfth dorsal and the first lumbar vertebra.

Complicated methods, in general, are likely to fail. Their drawback is that in case of failure another method has to be resorted to and this must be applicable to the operative field. I am not inclined to use spinal anesthesia, not even its modification as described by Kirschner, as long as I hear that there is one fatality in each 300 to 500 cases and that excruciating headaches are often observed.

As to the drawbacks of local anesthesia—it is said that it requires special training. This cannot be denied, but it is not a disadvantage. Moreover, in most operations the methods have been so greatly simplified that they may be easily learned.

Occasionally, a fall of blood pressure or certain toxic symptoms will occur. These, however, have become progressively more

uncommon. In any event, they cannot be compared with the more severe complications observed in general anesthesia.

It has been asserted also that some of the greater vessels may be injured. In infiltrating the deep layers I never use over-sharp needles and this makes orientation regarding the layers easier. Even if an injury occurs it will cause no serious trouble if reorganized, and if no anesthetic is injected into the vessel. In working near a vessel, if there is fear that the needle has entered, the piston is drawn back. If there is blood, the syringe is withdrawn. If the fluid is injected in such a manner that its jet precedes the needle, the stream of the fluid will drive the vessel away.

Tissue necrosis caused by anesthetics has also been described. However, I have never seen a single case of this. Those who have observed it must have infiltrated tense tissues or used great amounts of some highly concentrated fluid. Suppuration cannot be charged against local anesthesia, for both syringe and solution must be adequately sterilized.

As contraindications for infiltration anesthesia most authors mention malignant tumor, sepsis, inflammatory disease, youth, and obesity or hysteria in women. However, used far enough from the neoplasm, local anesthesia need not be feared. Moreover, operations for cancer of the tongue, cheeks, tonsils and throat have lost their bad reputation since the introduction of local anesthesia. In my opinion general anesthesia is contraindicated in septic patients. I never have seen suppuration at the site of the injection.

I never have been restrained by inflamed tissues from operating under local anesthesia and I have seen no unfortunate consequences. If the field is of small size I prefer circular infiltration in the healthy tissues, or I use block anesthesia, but if necessary, I do not refrain from infiltrating the inflamed tissue. In such cases I use a very fine needle and inject the solution slowly. In my experience, infiltration of inflamed tissues never causes spreading of the infection; it has rather tended toward quicker amelioration or even subsidence of the inflammation, possibly by abolishing pain. I readily admit, however, that there are cases in which a superficial ethyl chloride anesthesia is to be preferred to a more complicated local anesthesia, as, for example, in extensive mastitis.

Anesthesia must be induced without pain. Methods of induction, using intravenous or other anesthetics are needless. Local anesthesia requires gentleness, patience, and anatomic knowledge. The technique is now so simple that the patient feels, even in larger operations on the stomach or gall-bladder, only one or at most two superficial needle pricks. Because of this, we have operated on a steadily increasing number of children under local anesthesia. No untoward effect from block anesthesia has been observed in either diabetic or arteriosclerotic patients.

SUMMARY AND CONCLUSIONS

Advantages of local anesthesia are:

1. No medical assistant is needed during operation or until the awakening of the patient.

2. General anesthesia is fraught with grave dangers, but local anesthesia can be used safely. It has great importance in fractures, since if 20 c.c. of a 0.1 per cent pontocaine solution are injected between the bone ends, pain and muscular contraction promptly cease and the fracture may be easily and painlessly reduced.

3. In general medical practice it saves a great deal of suffering. Puncture of the pleural or of the peritoneal cavity, of joints, or of a paranephritic abscess can be done without pain.

There are certain operations which I never perform under general anesthesia. In heart disease, emphysema, bronchitis, arteriosclerosis, kidney disease, in impaired liver function or in bad operative risks, general anesthesia is contraindicated. Cosmetic operations and interventions that are not absolutely necessary (removal of scars,

benign tumors), certain plastic operations, herniorrhaphies, especially umbilical hernias of fat women, I perform exclusively under local anesthesia, because I consider it inexcusable to expose the patient to the danger of general anesthesia if the same operation can be performed safely under local anesthesia. The same applies to trepanation, operations on the face, mouth, neck, thorax, and the genitourinary system.

I myself employ general anesthesia only in certain abdominal operations and in operations on the extremities if local anesthesia has proved unsatisfactory.

Postoperative pneumonia is observed in patients operated upon under local anesthesia as well as those who have had general, but it shows a more favorable course and is more easily treated.

What is still to be required of an ideal anesthetic? Painlessness is of sufficient duration for the performance of the most extensive operations. It would be desirable, however, if the operative field could be made painless for at least twenty-four hours, because after pain sensation has returned, the patient does not breathe deeply and does not ventilate his lungs. If, however, pain could be abolished for six to eighteen hours, the patient would dare to move, to breathe deeply, and in this way many cases of pneumonia could be prevented. In this respect nupercaine opened a new perspective, but it has not fulfilled perfectly the expectations placed in it.

I am well aware that general anesthesia has changed its character, especially in America, where it has reached such a degree of perfection that its mortality rate has been reduced to a minimum and the dread of anesthesia has subsided.

Many patients prefer to be unconscious during operation and in some cases this may even be desirable, but others consider loss of consciousness unbearable and there are many cases where it is really contraindicated. From the psychologic point of view both types of anesthesia have their specific indication. General anesthesia should only be used if psychologic conditions contraindicate local anesthesia or make it impossible.

THE CHOICE OF ANESTHESIA IN OPERATIVE PATIENTS WITH HEART DISEASE*

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THE choice of the anesthetic to be administered to operative patients with heart disease has not always been given the careful consideration it deserves. Too often the surgeon merely determines whether he will use local, spinal, or general anesthesia without duly evaluating all the clinical factors, leaving the choice of the type of general anesthesia to the anesthetist. Not always is the state of the cardiovascular system sufficiently considered when a spinal anesthesia is chosen.

The anesthetist, though he may be an excellent technician, rarely considers the general condition of the patient, except to notice the pulse and temperature. Seldom does he take the precaution to ascertain the state of the cardiovascular system. The surgeon, on the other hand, having decided upon a general anesthetic, relies on the anesthetist to make the proper choice, and the anesthetist gives some form of inhalation anesthesia with which he considers himself most proficient.

In some hospitals progress along this line has been made. The anesthetist makes rounds on the patients to be operated upon, studies the clinical findings, and charts his recommendation as to the type of anesthetic to be used in the respective case. Should the surgeon disagree, he has the right to request the anesthetic of his (the surgeon's) choice, at the same time noting on the chart his cognizance of the anesthetist's recommendation and the reason for the desired change.

With the excellent laboratory facilities at our disposal at present, combined with our greatly enhanced knowledge of heart disease, there should be little excuse for a death due to sudden and unexpected failure of the cardiovascular system. There are some types of heart disease so fraught with danger from any operative procedure that the risk should not be undertaken if at all avoidable. When, however, such operations become imperative it is incumbent upon the medical man to inform the surgeon of the danger, and some responsible member of the patient's family should be acquainted with the facts, and made to realize that the doctor is fully aware of the risk that must be taken. In such cases a local anesthetic is to be preferred. To avoid the risk of an unlooked for cardiac death, I have made it a practice that, except in emergencies, all patients over the age of 40 have electrocardiograms taken prior to operation. Occasionally cardiac defects are revealed which have not, or could not, be elicited by the usual physical methods. Examples are lesser degrees of A-V block, A-V nodal rhythms, bundle branch block, and qualitative and quantitative changes in the deflection comprising electrical systole which indicate disease of the myocardium. None of these can be determined with certainty except with the aid of the electrocardiograph.

The most common types of heart disease, etiologically, are: (1) rheumatic, (2) arteriosclerotic, (3) hypertensive, (4) luetic, and (5) thyroid. Frequently two or more of these types may exist in one patient.

At the outset it may be stated that the risk involved is generally directly proportional to the degree of diminution of cardiac reserve. I may illustrate with an example: Suppose a 32 year old woman enters the hospital for menorrhagia. The pelvic findings are such as to warrant hysterectomy.

* Read before the New York Surgical Society, January 10, 1940.

But in the course of the preoperative workup a low-pitched, rumbling diastolic murmur is heard at the apex due to stenosis of the mitral valve. Further questioning reveals that the murmur has been present since the age of 10; that there have been three full term labors without difficulty; that the patient walks up three flights of stairs and does the family washing without undue dyspnea or fatigue. Obviously such a patient has little or no diminution of cardiac reserve despite the heart lesion. And clearly she is an excellent surgical risk.

At the other extreme is the case in congenital heart failure who just as obviously is a poor surgical risk. Between the two there are all gradations which can in part be determined by laboratory means, in part by physical examination by one familiar with heart disease. To the general statement made regarding the relationship of surgical risk and cardiac reserve, there are naturally many exceptions. I will try to enumerate a few of these.

In rheumatic heart disease, most frequently encountered in young individuals, one must be on the lookout for "rheumatic activity." By "activity" is meant the presence in the body of the exciting agent of rheumatic fever. In the heart, response to this agent manifests itself on the rheumatic verrucae on the valves, and the Aschoff bodies in the myocardium. "Rheumatic activity" may be determined in several ways clinically. It is sometimes manifested in the electrocardiogram by incomplete A-V block (prolonged P-R interval), or by abnormalities in the S-T segment and the T wave. Patients with acute rheumatic heart disease usually do not bear surgery well. In emergencies local or spinal anesthesia is the safest.

In the arteriosclerotic type some care must be used. These patients, of course, are not good risks per se, as the arteriosclerosis is generalized and has attacked other organs such as the liver and kidneys, has impaired their normal functions considerably, and any great strain upon their capacity can lead to disagreeable consequences. Due to the impaired cardiac circulation caused by a decrease in the size of the lumen of the vessels it is best not to give anesthetics that would lessen the oxygen supply to the heart musculature. For instance, nitrous oxide would be contraindicated. Straight open mask ether would be preferable, but such anesthetics as ethylene or cyclopropaine can be used. Although cyclopropaine is being widely used today, I am not one of its unqualified advocates. There have been instances where disagreeable sequelae, such as severe respiratory complications, have been observed.

In syphilitic heart disease the nature of the lesion largely determines the risk involved. The pathologic process may be one of the following: (1) aortitis with or without dilatation or aneurysm; (2) insufficiency of the aortic valve; (3) stenosis of the coronary ostia. The first group, even when large aneurysms are present, usually stands surgery well. The last group, conversely, usually does badly, and a considerable percentage die while still on the operating table. Local anesthesia only should be used for necessary surgery. The group with aortic insufficiency is a variable one. The choice of an anesthetic in patients with this lesion depends on the duration and extent of the lesion, the amount of left ventricular hypertrophy, and degree of diminution of cardiac reserve. It should be remembered that several of the pathologic processes detailed above may be present in the same patient.

When we come to the hypertensive cases —be they the essential hypertensives, those of unknown origin, or the nephritic type— we must think more in terms of diastolic pressure than of systolic. Even with a systolic pressure well within normal limits but with a diastolic pressure of 90 or above we should be forewarned. The great danger in this type of case is anoxemia, due either to the low oxygen content of the inhaled anesthetic or to the excessive oxygen unsaturation attendant upon capillary stagnation accompanying the lowered

blood pressure of a spinal anesthetic. Nitrous oxide should not be given; avertin should be used with great care; and spinal should be looked upon as dangerous. If the diastolic pressure is near 100 or above, spinal anesthesia should be used only if directly indicated and if the advantages of its use so greatly outweigh the disadvantages that the risk must be assumed. This type of case has become so used to the high pressure, especially in the cardiac circulation, that any great lowering of pressure over a period of time, such as would be required for some major operations, may cause a sufficient anoxemia to lead to fatal results. Dr. Clarence de la Chappelle has the records of a sufficient number of such fatalities to bear out this statement. A notation on the chart stating the reason for the use of spinal anesthesia in spite of the contraindications, and in spite of the anesthetist's warnings, at the same time giving due and valid reasons for the procedure, will preclude the surgeon from being blamed for a possible mortality on the grounds of ignorance.

The thyrocardiacs are so termed because it is often difficult to say whether the heart condition is the result of thyroid disease or merely concomitant. On the other hand, quite often it can be determined that there was no heart disease per se, and that the heart lesion is the result of overstimulation as part of the general increase of body metabolism due to thyrotoxicosis. As a rule, the latter stand anesthetics well. When we consider that we can give these highstrung persons avertin nowadays, let them go to sleep in their beds and find themselves in their bed when they wake up after a successful operation, there is really very little excuse for subjecting them to the terrific psychologic trauma of operation under local anesthesia. Most qualified authorities on thyroid surgery will use local only under exceptional circumstances when other forms of anesthesia are contraindicated. It should be stated at this time that auricular fibrillation in these cases is no contraindication to thyroidectomy. In spite of the fibrillation these patients stand operation well, and frequently the fibrillation disappears in a few days.

SUMMARY

1. The most common types of heart disease have been discussed from the standpoint of a choice of anesthetics.

2. Anesthetics have been chosen for each type of heart disease that will involve the least risk.

3. Contraindications to certain anesthetics in various types of heart disease have been emphasized.

4. A suggestion for the improvement of the service by a more careful consideration in the choice of anesthetics by both the surgeon and the anesthetist has been made.

SOME MECHANICAL DERANGEMENTS OF THE KNEE AND SHOULDER*

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THE knee joint is the largest joint in the body. Its skeletal structure is unstable, for it consists merely of the expanded ends of the femur and tibia, necessitating an ingenious and effective ligamentous system.

Derangement of the semilunar cartilages is the most common cause of intrinsic disorders of the knee joint, and the internal semilunar cartilage is the chief offender. It is estimated that it is involved four to ten times more often than the external semilunar cartilage. Because they are fibrocartilaginous in structure, the semilunar cartilages become torn in their substance rather than broken or fractured. The internal semilunar cartilage is firmly adherent to the capsule, whereas the external semilunar cartilage is loosely attached. These facts are important because, if the internal semilunar cartilage is caught between the condyle and the head of the tibia, it cannot escape, but will become ripped or torn in its substance. The external semilunar cartilage, due to its loose attachment to the capsule, has a certain amount of freedom, and thus may slip out of the grasp of the ends of the bones.

The crucial ligaments are also important. The anterior crucial ligament courses from the anterior part of the tibial platform near the tibial spine, upward, backward and lateralward to be attached to the lateral condyle of the femur. It prevents the tibia from slipping forward on the femur and prevents the femur from slipping backward on the tibai. The posterior crucial ligament arises posteriorly from the area contiguous with the tibial spine and courses upward, forward and medialward to be attached anteriorly to the medial condyle of the femur in the intercondylar notch. It prevents the femur from slipping forward on the tibia and prevents the tibia from slipping backward on the femur. The crucial ligaments are damaged in mechanical derangements of the knee joint more often than is realized, the anterior ligament being injured more frequently than the posterior. It is possible that the pull on the crucial ligament at its attachment to the internal condyle may have something to do with the formation of loose bodies in cases of osteochondritis dissecans.

In 1934, we made a study of the records of 560 patients who were suffering from derangement of the knee joint and who were operated on at The Mayo Clinic.[1] There were 587 operations: 343 for derangement of the semilunar cartilage and 244 for osteocartilaginous bodies. Three hundred and thirteen operations were performed for injuries of the internal semilunar cartilage and thirty were done for injuries to the external semilunar cartilage. There were four males to one female, and most of the patients were less than 30 years of age.

DERANGEMENT OF THE SEMILUNAR CARTILAGES

The patient is usually a male in the active period of life, and engaged in some active pursuit or sport when the injury occurs. The knee is usually in a partially flexed position with the foot externally rotated. (Fig. 1.) The pain consequent to the locking may be excruciating, there is

* Abstract of lecture given at the University of Minnesota, Center for Continuation Study, Minneapolis, March 14, 1939.

inability to extend the knee completely and swelling occurs within a short time. Later, when ambulatory, the patient may note a

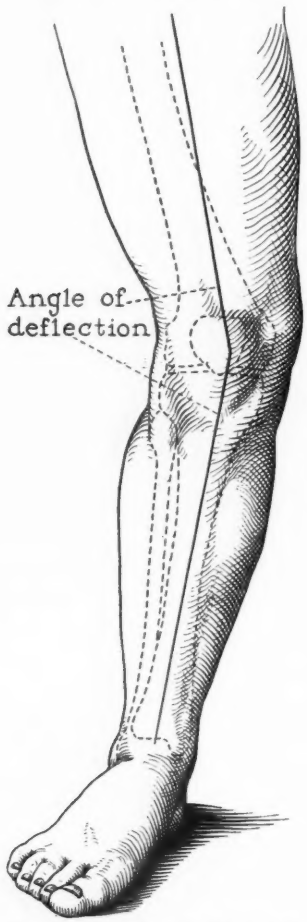

Fig. 1. Angle of weakness of knee; partial flexion with eversion of foot.

feeling of insecurity as if something were amiss in the joint. The pain is diffuse at first, but the tenderness gradually becomes localized, depending on which cartilage is involved, and the effusion gradually is absorbed. Usually, recurrent attacks of locking occur while the patient is engaged in some sport, but occasionally there is no history of injury and we have records of several cases in which locking has occurred on merely turning over in bed. The onsets tend to become more frequent as a rule, but the pain and ensuing swelling seem to lessen each time. The diagnosis rests almost entirely on the subjective symptoms, for when the patient presents himself to the surgeon there is usually nothing abnormal to be seen or felt in the knee and study of the roentgenogram usually gives negative results.

In mild cases of arthritis some confusion may arise as there may be a sensation of catching skin to locking caused by the synovia being nipped between the joint surfaces. Complaints of symptoms from other joints should serve to put the surgeon on guard. Osteocartilaginous bodies are readily detected by roentgenologic examination, but in some cases of the early stages of osteochondritis dissecans in which the body is not yet separated, there is a feeling of insecurity and instability similar to cases in which the semilunar cartilages are at fault.

Derangement of the external semilunar cartilage causes the same symptoms as derangement of the internal cartilage except that the pain is generally referred to the outer side of the knee in the former instance.

OPERATION

Unless locking of the knee cannot be reduced the first time that it happens, operation should not be performed until locking of the knee has occurred several times. If, in addition to locking, the internal semilunar cartilage is injured, it is preferable to make a small, anterior, internal incision across the triangular space bounded by the tibia, the condyle of the femur, the patella and the ligament of the patella, with the knee flexed to form a right angle. (Fig. 2.) If the external semilunar cartilage is involved, the space on the outer side of the knee corresponding with that just described should be opened. It is possible to remove the entire cartilage through an anterior incision, but if, in such an endeavor, the incision must be enlarged so as to endanger the lateral ligament, it is better to remove the anterior portion of the cartilage and to make a posterior lateral incision on the inner or outer side, depending on which cartilage is to be removed, and the posterior part of the cartilage

should be removed through this separate incision. The operation should be done with a tourniquet in place and after the operation is completed, the knee should be held for at least seventy-two hours on a posterior splint or in a plaster cast in almost complete extension.

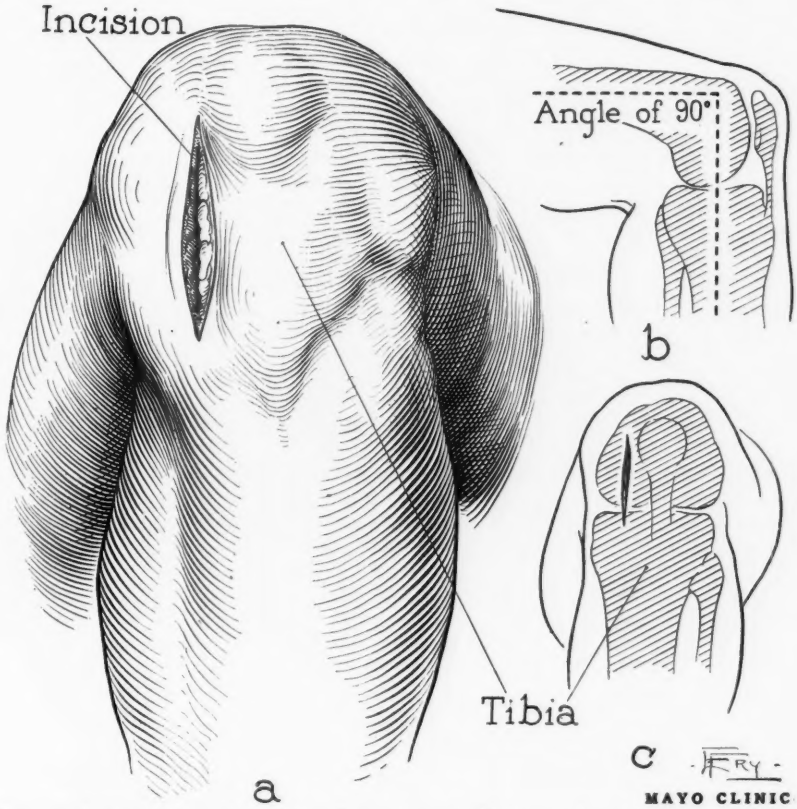

Fig. 2. Antero-internal incision for removal of internal semilunar cartilage.

PATHOLOGY

There are four types of tears or fractures which are most commonly seen in the internal semilunar cartilage. (Fig. 3.) One is a tag-like flap of the internal semilunar cartilage hanging from the anterior portion of the cartilage, which may flop back and forth and may be caught between the condyle and the tibia.

The second is also pedunculated, but arises in the middle third. If it is folded backward it may be difficult to see on opening the knee joint.

The third, and in our experience the most common, is the so-called bucket handle fracture described by Rutherford Morison many years ago. I think a better term would be "loop" tear, because it is in the form of a loop, being attached anteriorly to the anterior portion of the semilunar cartilage and posteriorly to the posterior portion. The loop lies in the intercondylar notch and prevents extension of the knee.

The fourth is a pedunculated tag or flap in the posterior third. This type produces bizarre symptoms and cannot be seen through an anterior incision.

The types of tears of the external cartilage are not so constant or so readily classified as those of the internal cartilage. In our experience the bucket handle type is the most common type of tear of the external cartilage.

Of the 343 operations, there were 122 in which a fracture was not demonstrable whereas, in 221 instances a fracture or tear could be shown. Derangement may be

caused by a hypermobile cartilage which manages to slip out of the grasp of the ends of the bones before actual damage occurs. possibility should be explained to patients before operation if any instability of the knee is present and they should be warned

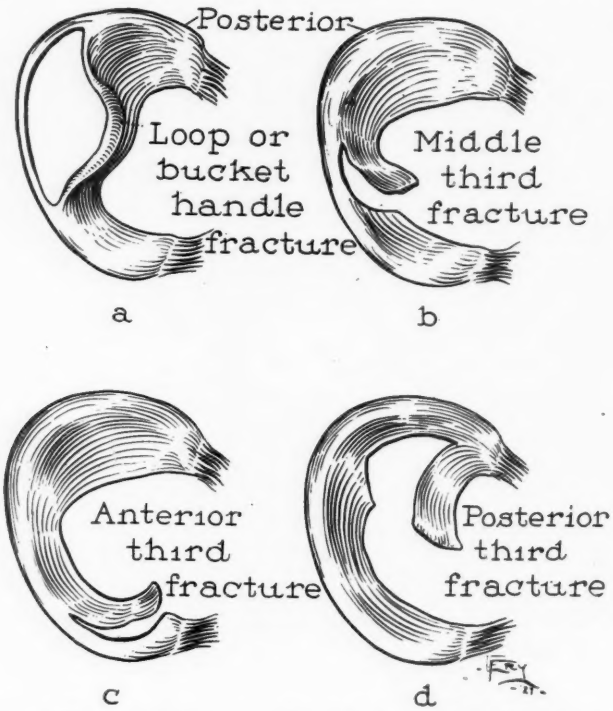

FIG. 3. Four common types of tears in internal semilunar cartilage. (From Henderson, in *S. Clin. North America*, 7: 1425, 1927.)

The symptoms are very similar to and usually cannot be distinguished from those which are present when a fractured cartilage is the cause of the disability. However, the percentage of good results among patients who had the cartilage removed because it was thought to be hypermobile is not so great as among those who had tears or fractures of the meniscus that were demonstrable at operation.

RESULTS

Complete relief was obtained in 77.3 per cent of the cases in which operation was performed. In addition, in another 15.3 per cent of these cases definite improvement and relief of many of the symptoms were noted. In 7.4 per cent improvement did not occur. I feel sure that in some of the cases, failure to realize relief was due to the fact that severe injury and partial rupture of the crucial ligaments had occurred. This that, although the operation will relieve the locking or catching in the knee, if they have ligamentous injury the weakness will probably persist.

OSTEOCARTILAGINOUS LOOSE BODIES

Derangements due to osteocartilaginous loose bodies may be classed under three headings: first, those in which the bodies arise because of osteochondritis dissecans; second, those due to osteoarthritis; and third, those due to osteochondromatosis.

Osteochondritis dissecans and osteochondromatosis occur in young patients, whereas osteoarthritis occurs in the more elderly. In the aforementioned group study there were 233 patients, 187 males and fifty-seven females, who were operated on for the removal of loose bodies in the knee joint.

Osteochondritis Dissecans. One hundred and thirty-five of 233 patients had loose

bodies due to osteochondritis dissecans. (Fig. 4.) There were 105 males and thirty females. The internal condyle was the site

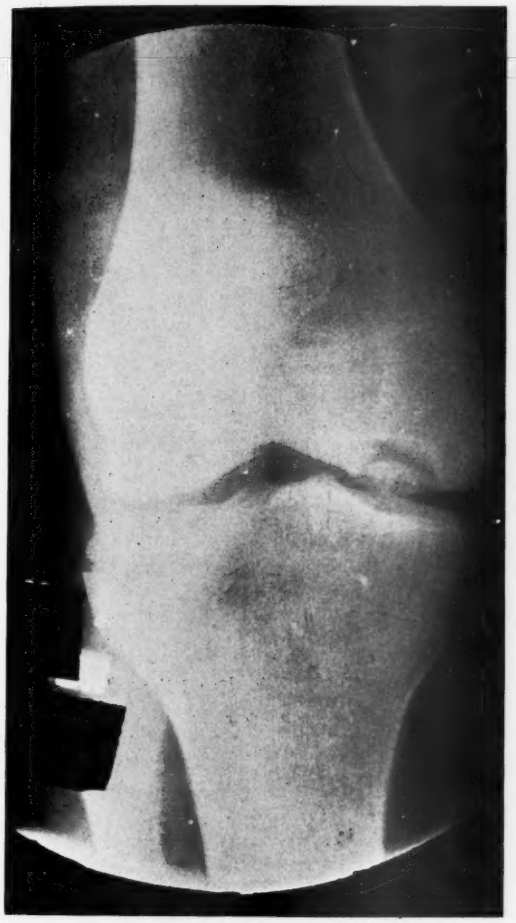

Fig. 4. Osteochondritis dissecans of the internal condyle of the femur. (From Henderson, in *South. M. J.*, 19: 633, 1926.)

of origin in 118 cases. In some cases it was impossible to determine from just what place the loose body arose, but in a few it evidently originated from the external condyle. The etiology of osteochondritis dissecans is not understood thoroughly, but it is probable that there is a blocking of an end artery with consequent aseptic necrosis of a portion of bone and cartilage, and the body is cast off and wanders about the joint. Loose bodies in cases of osteochondritis dissecans are usually single and rarely exceed two or three in number and they may be completely covered with cartilage because, as they wander about the joint, sufficient nourishment is obtained from the synovial fluid to allow formation of cartilage that will completely surround the body. In a few cases loose bodies were removed

Fig. 5. Osteochondromatosis with multiple osteocartilaginous bodies.

from both knees. When the body is removed, the roughened edges about the region from which it has been derived should be smoothed down.

Some adolescent patients may have very indefinite symptoms. They may complain merely of a feeling of insecurity in the knee. There may not be much pain, but a disability may curtail activity. Later on, the body shows up on roentgenologic examination.

Osteochondromatosis. We believe that osteochondromatosis is a benign neoplastic process. (Fig. 5.) The bodies originate in the synovial membrane, usually at the margins where the membrane is reflected from the bone, but occasionally the entire synovial sac participates in the process. Small pedunculated tags of tissue hang down and become fibrous on the tip; then cartilage and bone actually form in them. They become broken off as they become larger and heavier, and wander about the joint. As long as these bodies are attached by a pedicle and have a blood supply, the

bone in them is alive, but on breaking free from their pedicle the bony portion becomes necrotic. The number of the bodies varies greatly in cases of osteochondromatosis. Several cases have been reported in which more than a thousand loose bodies have been removed and there are many in which a hundred or more have been found in one knee joint.

Some recommend that a complete synovectomy be performed in every case, but in most of ours we have merely removed the wandering loose bodies and the bodies attached by pedicles. There have been few recurrences.

Osteocartilaginous Bodies Due to Osteoarthritis. Osteoarthritis of the knee is a common condition in elderly people. Not infrequently the osteophytic growths become very large and pieces break off within the joint and become wandering loose bodies. The number of these bodies rarely exceeds three or four. Many elderly patients have very little trouble with them and in that case removal is not advisable. However, if the bodies cause locking, they can be removed easily under local anesthesia. The patient must be warned that removal of the bodies will prevent the catching and locking only, but will in no way help the arthritis.

Osteocartilaginous bodies vary in size and shape. Those which stay at the periphery of the joint and do not wander much are mulberry-like and rough, whereas those which are free to wander become very smooth and polished.

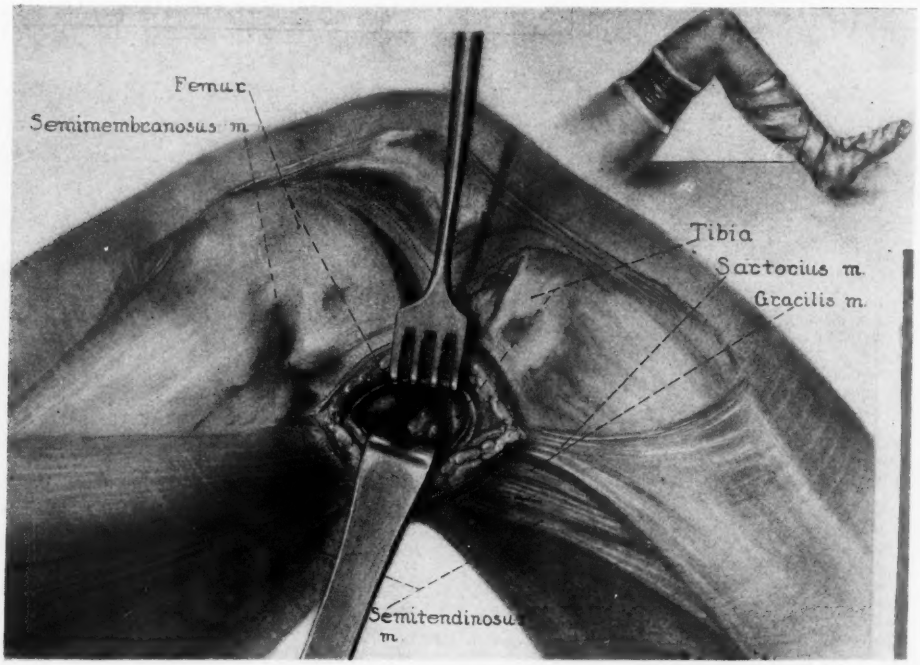

FIG. 6. Postero-internal incision for removal of loose bodies from posterior compartment. (From Henderson, in *Surg., Gynec. & Obst.*, 33: 698, 1921.)

Sometimes the loose bodies retreat into the posterior internal or posterior external compartment where they cannot cause locking. In this situation they are best reached by posterior internal or posterior external incisions at the margin of the joint, just anterior to either hamstring. (Fig. 6.) With the knee partially flexed to relax the hamstrings, the capsule lies just beneath the skin and fat in this region. There is a median raphé in the midline and an instrument cannot be passed from the external posterior compartment to the internal or vice versa. If bodies lie in both compartments, bilateral incisions must be made.

RECURRENT DISLOCATIONS OF THE PATELLA

Recurrent dislocations of the patella are comparatively rare. In 1933,[1] I made a

study of a group of such cases at The Mayo Clinic and found that we had operated on thirty-five patients who had recurrent dislocations of the patella.

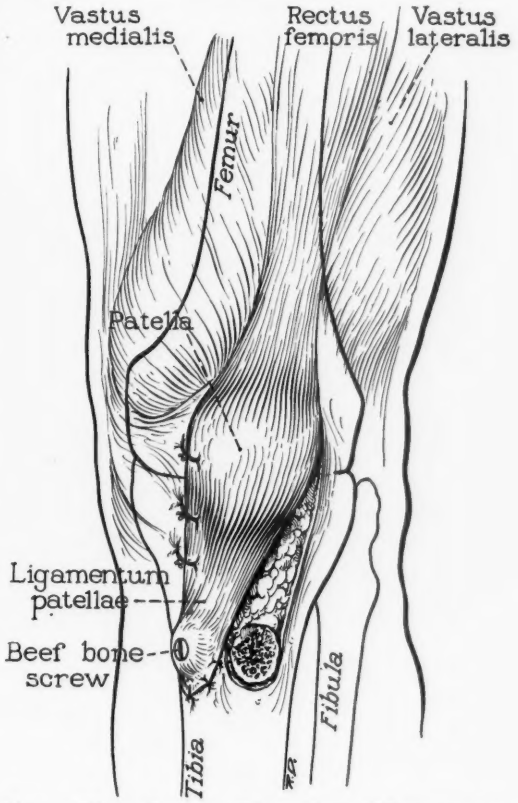

Fig. 7. Transference of insertion of ligamentum patellae inward to prevent recurrent dislocations of the patella.

The diagnosis is not always easy, for the surgeon seldom sees the patient when the patella is dislocated. The patient describes a sudden "giving-away" of the knee, accompanied by pain which is so severe that the abnormal position of the patella is not noticed. Usually some friend pulls on the knee and the patella "goes back" with a snap, much as happens when a semilunar cartilage is at fault. Since injuries of the cartilages are more common than dislocation of the patella, it is generally assumed that derangement of a cartilage has occurred.

There are several points in the differential diagnosis that are worthwhile. First, dislocation of the patella usually occurs in young women, whereas cartilaginous injuries usually affect men, predominantly; second, there is occasionally a family history of dislocation of the patella, and third, the condition may have occurred previously in the opposite knee. It is better not to operate until there has been a sufficient number of dislocations to enable the patient to tell whether the patella slips outward during the attack. A knock-knee deformity may be present. A clue may be obtained by the examiner in the following manner: He should sit beside the patient, see that the patient is thoroughly relaxed, the examiner holding the knee extended; then the examiner should gradually flex the patient's knee, at the same time pushing the patella laterally. As a flexion of about 150 degrees is reached the patient will usually grab for the knee and exclaim: "That is the way it happens."

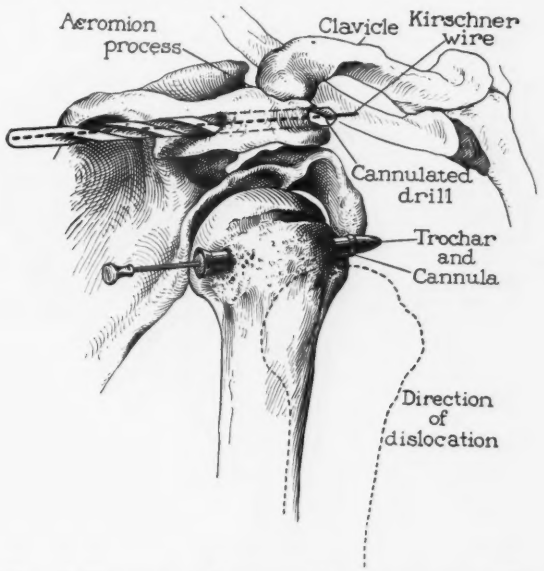

Fig. 8. Tenosuspension operation for recurrent dislocation of the shoulder. Diagrammatic drawing showing the method of drilling holes through the bone and the use of a trocar and cannula to facilitate insertion of the tendon. (From Henderson, in *J. Bone & Joint Surg.*, 33: 978, 1935.)

The etiology is not certain. Some surgeons maintain that the external condyle is deficient, that is, the anteroposterior diameter is subnormal and thus the patella slips off it easily. Another explanation is that the patella is small and triangular in shape. Probably both of these contribute partially in causing the condition.

Swelling follows the attack and there may be ecchymosis, particularly at the

time of the initial dislocation. Ecchymosis is not commonly associated with derangements of the semilunar cartilages.

the patient will have considerable difficulty in flexing the knee, because the new contact areas of the patella and femur must be

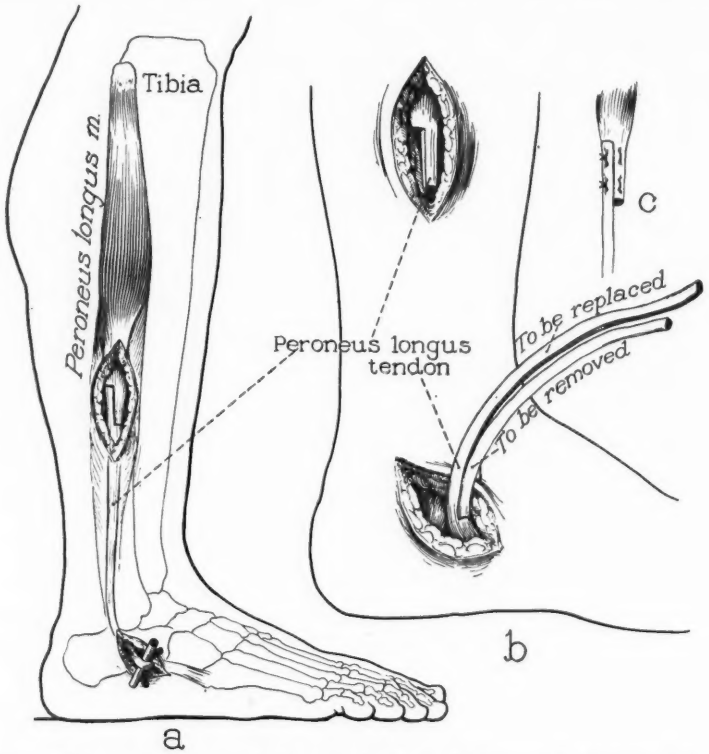

Fig. 9. Method of removal of a strip half the thickness of the peroneus longus tendon; the remaining half is sutured back into place. (From Henderson, in *J. Bone & Joint Surg.*, 33: 978, 1935.)

The treatment is simple in principle.[1] The operation which we prefer is one in which the insertion of the quadriceps tendon, along with a piece of bone of fair size is lifted up and transferred well inward and downward onto the flat internal surface of the tibia, so that when extension of the knee is attempted the pull of the quadriceps tendon will be such that the patella is pulled inward rather than outward. (Fig. 7.) If this procedure is carried out properly, the chances of failure are practically nonexistent. I believe that all the failures that we have had after this type of operation have been due to permitting too early use of the knee or to technical errors.

In our aforementioned group, there were thirty-nine operations on thirty-five patients, some of these patients requiring bilateral operations. In thirty-three of the cases, 94 per cent, the results were excellent. For about a year after the operation, broken in, as it were. It is essential that the knee not be flexed sufficiently to exert a pull on the new insertion of the quadriceps tendon until this insertion has become firmly adherent in its new position, certainly not before three months have elapsed. When the quadriceps tendon and its insertion are transplanted, a large piece of bone should be taken up with it and then either placed in a carefully prepared slot in the cortex on the inner side of the tibia or held firmly to the bone by a beef bone screw or some such means until union develops.

OSTEOCARTILAGINOUS LOOSE BODIES IN THE SHOULDER JOINT

Occasionally, loose bodies are to be found in the shoulder joint. They cause irregular painful catching and locking. It is our opinion that the loose bodies encountered in our cases were due to osteochondromatosis. Their removal relieved the patients.

Sometimes removal can be accomplished by a single posterior incision, since the capsule is more readily accessible at that point, and by manipulation of the shoulder and pressure on the joint bimanually, the loose bodies can be forced to the posterior compartment and removed.

HABITUAL OR RECURRENT DISLOCATIONS OF THE SHOULDER

This condition is commonly encountered among men, particularly those who engage in athletics. The etiology is not known, and considering the skeletal structure of the shoulder joint, it is a marvel that these habitual dislocations are not more common than they are. The head of the bone is held in place chiefly by muscular action.

Recurrent dislocations usually follow a primary traumatic dislocation. However, sometimes the initial dislocation follows such a slight strain that it cannot be called a true traumatic dislocation. Thereafter, dislocations occur on some trivial movement, such as stretching forward to grasp an object or even during sleep. Some authorities claim that the head of the humerus is misshapen, but in our cases we could not feel certain that this was true. In those cases in which the head was misshapen there had been so many dislocations and so many reductions that the distortion could be attributed to them. The patient is not only incapacitated and subject to much pain by the actual dislocations, but also becomes continually apprehensive and fearful of possible dislocation.

There are a number of surgical procedures available, and perhaps I can best illustrate the point that I wish to make by reviewing briefly the last report that I made on this condition in 1935.[2] Up to that time we had operated on sixty patients. In nineteen we had done the old capsulorrhaphy operation, i.e., reefing and overlapping the capsule as one would overlap tissues in an operation for hernia. The results in these cases were disappointing. Only 37.5 per cent of the patients were completely relieved. We then turned to the Claremont operation, which consists of making a long posterior incision and lifting up the posterior fourth of the deltoid muscle, carrying it forward through the quadrilateral space anteriorly and then, by means of a small anterior incision, fastening it to the coracoid process. But again, the results were disappointing. Of eight patients, four, or 50 per cent, experienced a recurrence. Finally, in 1924, we turned to what I called the tenosuspension operation (Fig. 8), which consists of taking a piece of the peroneus longus tendon from the patient's leg and placing it through a hole bored in the head of the humerus and through a hole bored in the acromion process, thus making a suspensory ligament entirely extra-articular for the head of the humerus. This procedure has given us our best results. Of twenty-nine cases there were twenty-six, 90 per cent, in which further trouble did not occur, and the results in our later cases as we grew more experienced in the operation, have continued to be even better than that. The Nicola operation is the same as the tenosuspension operation in principle, but has the disadvantage that the tendon traverses the joint. This necessitates opening the joint and entails considerable dissection.

The postoperative period of disability in the tenosuspension operation is brief. The patient is usually in the hospital for only about ten days or two weeks. We now use only one-half of the peroneus longus tendon (Fig. 9) and the patient walks on the foot in a week without difficulty. We have had a number of athletes, such as boxers and swimmers, who have carried on very efficiently after the operation.

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THE INDUSTRIAL BACK FROM THE INTERNIST'S VIEWPOINT*

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IN complete disregard of the multiple causes of backache, the tendency in industrial medicine is to "mass group" all these cases under the diagnosis of "back sprain." This error seems to be predicated upon the "locale" of the onset of pain. If it occurs while a man is cutting his own lawn, the term lumbago is invariably applied and the condition is attributed to causes within the man. However, if the pain arises while a man is stooping, bending or lifting at an industrial plant it is called back sprain and considered the result of motion while working for someone else. The situation assumes added import when it is appreciated that this disability is becoming one of the most frequent claims for compensation.

In the series offered for consideration, an *inadequate* or negligible history of injury occurred in over 70 per cent of the cases. Obviously, then, the history should determine the basis for investigation before accepting or denying the occupational origin. The patient brought in disabled because of a fall from a ladder or platform requires such an examination as will determine the extent of his injury, but the man who becomes disabled while engaged in a simple motion requires an investigation upon more divergent lines. It is imperative that criteria of normal and abnormal motion or movement be established in the examiner's mind. If the origin of pain is to be evaluated and its responsibility allocated, the above statement must become indelibly fixed in the minds of all industrial physicians.

Despite the contention that in the evolution of man instability of the lower back occurred when he assumed the orthograde position, there does exist a normal, physiologic range of motion. Sprain is defined as an overstrain, the result of excessive motion. Accepting the last two statements as a premise, how can a motion to which one is accustomed, one executed daily in the same manner, one within the normal range and lacking the qualities of excessive, strenuous or unusual, constitute a sprain? Yet, beyond any question of doubt, mild to severe disabling pain does occur following a normal motion or a trivial act. Why? It should be apparent that it would not have occurred had there not been an added factor, an unrealized factor, present. It must be this added factor, this added "straw" that "breaks" the patient's back. The failure to search for it in industrial medicine has resulted in the preponderant diagnosis of back sprain.

The sacroiliac cause or theory will receive no mention other than to state that despite its refutation by reputable investigators it still finds wide acceptance. Invariably the diagnosis is made without benefit of *x*-ray. Such acumen is uncanny or simple sorcery. Sacralization, failure of fusion, abnormal articular facets, spondylolisthesis, horizontal sacrum, the narrowed intervertebral disc, herniation of the disc, hypertrophy of the ligamentum flavum, and contracture of the iliotibial band have been accepted or condemned as a cause of back pain. Judovich and Bates detract importance from the lumbosacral area and indict the dorsolumbar junction. Markoff attributes much back pain to a vasospastic disorder. Ridlon and Berkheiser call attention to the calcareous

* From the Special Examination Department, Golden State Hospital (C. E. Early, M.D. and Associated Staff). Read before California State Medical Association May 2, 1939.

degeneration of the abdominal aorta as pertinent to backache. The author had one such unquestionable case in this series and eight others where this apparent circulatory deficiency was considered contributory. Gratz, using pneumofasciograms, demonstrates adhesions which he believes are the preponderant cause of back pain. Faulty posture, poor nutrition, insufficient exercise and ignorance as to how to execute motion are definite sources of back pain. Allergy, endocrine imbalance and referred pain from adjacent organs must be considered in this passing parade of possibilities. Finally, but most important, are the secondary effects from systemic or focal infection. Why this last mentioned source is accorded such negligible recognition by the industrial physician is beyond understanding. Pain occurring in the knee, elbow or shoulder invariably institutes a search for infection elsewhere in the body. Are the fascial planes and the vertebral joints not just as susceptible?

Consideration of all this varied etiology outlined in the review just completed stimulated the study offered in this paper and initiated three years ago. That the term *back sprain* could be applied to approximately 80 per cent of these disabilities appeared unreasonable and unscientific. It was felt that an adequate answer could be obtained only by studying a sufficiently large series of cases and only those cases where the onset of pain allegedly occurred while the patient *was working*. The series represents all ages, races, various social levels and all types of industry.

In the clinic where this material was gathered the following procedure is observed. Excluding the recently traumatized back (severe falls, crushes and blows) every patient alleging back pain is referred to the Special Examination Department. Following a detailed, exacting history and a complete physical examination, *x*-rays, urinalyses and blood counts are done routinely. If indicated and when necessary to establish the diagnosis, further *x*-rays of teeth, sinuses, lungs, genitourinary tract, etc., are made; also blood Wassermann, blood chemistry, blood sedimentation, smears and cultures are taken. The data gathered from this three year study are presented in the tables.

Table I

(April 1, 1936–February 28, 1939)

No. of cases	3,018
Percentage of total clinic admissions, 1936	7.6
Percentage of total clinic admissions, 1938	10.4*
Males	2,799
Females	219
Average age	36.2 years
Patients referred to clinic diagnosed as back sprain	74 per cent
Patients referred to clinic diagnosed as sacroiliac disease	5 per cent

* Note the increase of 2.8 per cent of back claims in 1938 over 1936.

Special attention is directed to the group of patients seen, treated, and diagnosed elsewhere before being referred to this clinic. These figures indicate that practically 80 per cent of the patients coming in from general industrial practice had been accepted as arising out of and due to occupation.

Table II

	No. of Cases	Accepted	Rejected	Percentage of Rejections
1936 (nine months)	722	433	289	40
1937	1,092	564	528	49
1938	1,014	315	699	59
1939 (two months)	190	56	134	71
Totals	3,018	1,368	1,650	Average 57

The reason for the sharp rise in the percentage of rejections found in Table II is that in the summer of 1937 a policy of unlimited laboratory investigation was adopted. This resulted in finding pathology which, when considered with a negligible history of injury, formed a basis of rejection. While the entire average rejection over a three year period has been only 57 per cent, the rejections for 1938 and to date in 1939 averaged 70 per cent.

TABLE III

Findings	No.	Per Cent
Accepted cases. Contusion	423	31
Accepted cases. Leucocytosis	...	3
Rejected cases. Leucocytosis	...	37
Rejected cases. Abnormal urine, smears, serology, blood chemistry, etc	...	13
Rejected cases. History of previous back disability	...	42
Rejected cases. Fever	...	11

TABLE IV

Throat infection	301
Defective oral hygiene of significant degree	696
Coryza	127
Pleurisy	31
Pneumonia—pain in dorsal area first symptom	2
Cholecystitis	5
Gallstones	3
Aneurysm	1
Aortitis with positive serology	6
Coronary heart disease—suspected	12
Appendicitis, with chief complaint of back pain	3
Kidney stones	16
Nephritis with urinary evidence	63
Pyelitis	3
Cystitis	1
Hydronephrosis	7
Pyonephrosis	1
Acute gonorrhea (back pain reason for examination)	42
History of gonorrhea	512
Enlarged uterus—tumor	2
Abortion (called industrial doctor because of backache)	1
Abnormal prostate	208
Pylonidal cyst (alleging its presence as resulting from contusion or strain)	26
Pernicious anemia (presented himself because of "sciatica" of legs from heavy lifting)	1
Tabes	3
Lead poisoning (back pain first symptom)	1
Bronchiogenic carcinoma (presented himself because of dorsal pain)	1
Cancer of prostate	3
Obesity (marked, with recurrent back pain but normal spine)	4
Obesity (marked, with recurrent back pain, with congenital defective spine)	9
Adiposogenital dystrophy (age 13; back pain after one day of lifting grocery baskets)	1

Tables III and IV comprise exhibit A in the indictment of the universal usage of the term "back strain" as a diagnosis of backache in the working man. Of the accepted cases, one-third revealed a history of actual contusion, leaving only two-thirds, or 945 out of 3,018 cases, to be accounted for by unusual stress or strain or extraordinary circumstances. One cannot pass over lightly the fact that of the rejected cases 51 per cent had abnormal laboratory findings. Nor can one observe the extensive pathology listed in Table IV without realizing that the workman is subjected to the same ills all man is heir to and, therefore, the origin of his pain should not be stereotyped.

TABLE V

Patients *x*-rayed	2,414	
Lumbosacral pictures	1,929	
Cervical pictures	305	
Dorsal pictures	180	
Osteoarthritis		24.6 per cent
Cancer of vertebral bodies	6	
Myeloma with involvement of spine	1	
Kummell's disease	5	
Nuclear expansions (Schmorl's cartilaginous nodules)		32 per cent

TABLE VI

Variations in lumbosacral area	1,929	
Sacralization		14.6 per cent
Bilateral		5.2 per cent
Unilateral		9.4 per cent
Failure of fusion		18.4 per cent
Horizontal sacrum		3.4 per cent
Narrowed lumbosacral disc		52 per cent
Spondylolisthesis		2.8 per cent
Posterior displacement of fifth lumbar	21	
Articular facet variations (incompletely studied)		1.6 per cent
Nucleus pulposus—herniation into canal	3	

A narrowed lumbosacral disc found in 52 per cent of the cases is evidently a smaller number than that found by Williams and others. Our figure represents cases which showed not only a wedging of this disc but a diminution of the foramina. Efforts to determine cord pressure or blockage by posterior displacement of the nucleus pulposus have been but recently begun in the clinic so that we have no knowledge as to how often it might have been present in this series. Posterior displacement of the fifth lumbar is found in twenty-one cases in our series. We believe that these are not optical illusions, as Willis warns they are apt to be.

CONCLUSION

Any conclusion that backache has a multiple and varied etiology is redundant. There prevails no paucity of possible

causes. But the amazing revelation to be garnered from this study is that in spite of the recognized causes and irrespective of the possible pathology existing to explain backache, a diagnosis of assumption—a blanket diagnosis—occurs in 80 per cent of these cases. This paper contends that if a cause is sought by individual study of the case, a reversal of these figures takes place. This three year study would show that in the general industrial practice 75 per cent to 80 per cent of all back cases are considered occupational in origin and cited for compensation, whereas our clinic accepts only 30 per cent as arising from employment; and 70 per cent are denied compensation. The basis for this difference is to be found in personal opinion, interpretation of certain definitions, and in the employment of a thorough investigation.

1. The preformed mental attitude of the examiner. Prejudice, grievance or mercenary desire may automatically disfavor the employer or carrier; or the physician may favor the carrier too frequently by suspecting the majority of such patients as being malingerers. Personally, we believe that few, if any, acute back cases are true malingerers.

2. The individual interpretations of certain fundamental definitions.

(*a*) Sprain. This has already been defined. To use this diagnosis, the examiner must weigh the alternates of usual or unusual, normal or excessive, an ordinary or an overt act.

(*b*) The purpose behind and the philosophy of workman's compensation. Liability as intended by this code must be squarely interpreted. Liability can be imposed for only those disabilities that are caused or aggravated by circumstances, conditions and environment which constitute a hazard and to which normally one would not be subjected. Therefore, one must ask, *does normal motion* constitute an industrial hazard?

Finally, from the internist's viewpoint, the disabling back is not an industrial entity. The practice of according it the same occupational earmarks as are attributed to silicosis or lead poisoning, for instance, is a fallacy. Such an assumption constitutes an economic injustice to industry in general as well as an unjust consideration of the patient who deserves a diagnosis. From the internist's viewpoint the so-called "industrial back" is not primarily an orthopedic problem. It is one for differential diagnosis. From his viewpoint and study, disease and infection comprise a considerable portion of the etiology.

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A RENAISSANCE OF SUTURE TECHNIQUE NEEDED

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A RECENT editorial in the *Journal of the American Medical Association*,[1] entitled, "The Renaissance of Silk in Surgery," must be viewed with considerable disquietude. Apparently a cycle of surgical technique has been completed, and we are now about to enter a new one making the same mistakes which we did not learn to avoid in the last. A general recommendation for silk cannot ignore the contraindications for the use of this material, nor can the surgical technique generally employed for suturing be transposed to the use of silk without causing a greater number of complications than is encountered at present. After Lister introduced "antiseptic" catgut, many surgeons continued to have wound complications as before, but at least, as Godlee pointed out, the introduction of the antiseptic absorbable suture retired to oblivion the use of non-absorbable sutures with ends hanging out of the wound in order that they might be removed later when suppuration started. Kocher with his "fort mit dem Catgut" successfully introduced the use of "antiseptic" silk on the continent, and his work inspired Halsted to use silk with equal success in this country.

But Halsted fully realized the danger of every surgeon's adopting the use of silk, and those who quote him usually fail to repeat what he said about a proper technique for this material.[2] His catgut-silk paradox is as follows:

"Paradox, because (1) a surgeon uses catgut because he cannot get good results with silk—has stitch abscesses continually from ligatures as well as sutures. (2) A good surgeon (Kocher for example) says, 'I have no trouble since I gave up catgut and commenced using silk exclusively.' The surgeon hears this and says, 'Well, now I understand why so few of my wounds heal well. I should have used silk instead of catgut.' I said, 'Don't try silk, you will have more trouble than with catgut.' Explanations followed. A bad technique will get best results with catgut. A good technique best results without catgut, that is silk. Good and bad results are relative terms. Almost anyone can get pretty good results with catgut but no one gets perfect results with catgut. To prevent even an occasional failure the good technician resorts to silk. In the hand of a bad technician silk is disastrous."

Silk found wide acceptance in Europe on the recommendation of Kocher, but soon chronically draining sinuses began to result from operative wounds which became infected and these were finally so prevalent that surgeons working in the out-patient departments carried crochet hooks as standard equipment to "fish out" silk sutures. More recently, Whipple[3] has told of the necessity of abandoning the use of silk when he first introduced it on his service because of lack of proper employment and the complications which developed. Shambaugh[4] has also indicated that the use of silk was abandoned for a number of years at the Peter Bent Brigham Hospital. The use of silk will also suffer setbacks in this renaissance if the warnings regarding its mode of employment are not carefully heeded. The crochet hook should not return again, but already commercial houses are selling silk "for use in general surgery" of diameters two or three times the correct sizes recommended by Halsted.[5]

Certainly there is no need to use silk because of catgut allergy, and more important still, the use of catgut should not be given up for this reason. The myth of catgut allergy needs to be exploded once and for all. Is it not unusual if there is a true allergy for catgut, that the only manifestation of this allergy is an inflammatory reaction in the wound which can also be

produced by tying sutures too tightly or from not observing a rigid aseptic technique? In the single instance reported in the literature of a supposed allergic manifestation to catgut other than a complication of wound healing, Tripp[6] theorized that his female patient developed asthma after an operation because her incision had been sutured with catgut, but he did absolutely nothing to prove that the attack had not resulted from one of many other causes of asthma.

Moreover, when experiments are quoted in support of the thesis of catgut allergy, apparently the investigations of Reil,[7] Frugoni,[8] and Gratia and Gilson[9] are forgotten because they do not indicate that a specific allergy exists. These workers demonstrated, for example, that (1) catgut cannot be antigenic as it is absorbed and, therefore, could not produce an acquired hypersensitive state; (2) precipitation tests for catgut antibodies were negative, showing that a natural hypersensitive state does not exist; and (3) any reaction produced with catgut after so-called sensitization is nonspecific.

Recently, from the Royal University of Pavia, Beluffi[10] reported the results of an extensive investigation on the subject of catgut allergy, and came to the conclusion that "catgut does not possess antigenic properties; the previous introduction and absorption of catgut do not produce a sensitization toward it or toward other proteins; and the reactions to catgut are interpreted not as allergic phenomena but more probably as foreign body reactions." Finally, just a few months before this editorial[1] appeared, Pickrell[11] was unable to substantiate the work of Kraissl[12,13] which was quoted in the editorial as the proof of catgut allergy. In this investigation at Johns Hopkins University, no wound disruption occurred in either rabbits or guinea pigs previously treated with catgut when proper aseptic precautions were observed in the repair of the wound. Pickrell pointed out that, in Kraissl's illustrations, one of the wounds which disrupted shortly after the repair occurred on an abdominal wall inadequately shaved. Besides, neither guinea pigs nor rabbits, as Kraissl had claimed, could be sensitized to commercial catgut, or to a catgut extract furnished by Kraissl, and no evidence of sensitivity to catgut could be demonstrated in three patients whose wounds disrupted. In this regard, it should be mentioned that Glenn and Moore[14] found an incidence of disruption of 0.68 per cent in catgut sutured wounds and 0.61 per cent when silk was used. Lastly, in one hundred patients tested with catgut extract before and after operation, no sensitivity could be demonstrated; and therefore Pickrell concluded "that although catgut, like any other suture material, acts as a foreign body and causes a slight leukocytic response, it does not act as an antigen to induce the hypersensitive state." The truth, then, should be admitted that a poor suture technique undoubtedly accounts for the wound healing complications too glibly attributed to catgut allergy.

It can reasonably be questioned how much the comparison of the results of the healing of clean wounds sutured with silk and catgut is influenced by better suture technique and the use of fine sizes when silk is employed. Indeed, the most rabid proponent of silk would admit that catgut is the better suture material if large sizes of silk were used by the technique of suturing usually employed for catgut.

Too often the indications and contraindications for the different suture materials are forgotten. The best example of this comes in the form of a letter written to the *Journal of the American Medical Association*[15] praising this same editorial and stating that ever since catgut and clips had been abandoned in mastoid operations (for what other reason than to close the skin?) the results have been excellent. Elementary as the statement must seem, to some, apparently, it must be reiterated again and again that catgut cannot be used to suture the skin because suppuration and

complications invariably develop. In other words, the use of catgut in the skin is definitely contraindicated. Equally as obvious, but apparently as frequently overlooked, is the fact that catgut should not be used in the subcutaneous fat except as very fine interrupted sutures to repair a subcutaneous fascia if this layer is sufficiently well-developed; better still, that catgut should not be used at all in this location. Induration of the wound results and, as Halsted pointed out, a few drops of serum are discharged on the ninth or tenth day. Silk also has its contraindications. It cannot be used with any degree of safety to suture the mucosa of hollow viscera. Mitchell[16] and Soresi[17] have reported the formation of chronic ulcerations about silk sutures in the gastrointestinal mucosa, and in the mucosae of the urinary bladder and gallbladder nonabsorbable sutures act as nidi for calculi. On the other hand, there is no question about the efficacy of silk in thyroid surgery and for the repair of cut tendons and nerves.

When these indications and contraindications are considered, it is obvious that in the repair of clean wounds in different tissues the best results will not always be obtained by using one type of suture material; that both catgut and silk are needed and probably will be for some time. In spite of all that has been written against the absorbable suture for the repair of the clean wound, catgut is still used by the great majority of surgeons, although admittedly rather poorly, and the principle of absorbability of the suture has definite merit. Neither can the fact be ignored that catgut is almost universally used for the repair of contaminated wounds, although Shambaugh and Dunphy[18] write that wounds repaired with silk tolerate bacterial contamination better than similar wounds repaired with catgut. However, they used much larger catgut than silk, and the simple law for the comparison of the chemical nature of foreign bodies dictates that physically they should be of the same magnitude.

There is no doubt that the healing of wounds could be immensely benefited in general by improving suture technique, but the endless argument about the type of suture material to use totally obscures this solution. Suturing is still in the basting stage and the selection of the size required is judged more, as Harvey[19] points out, on the basis of the physique of the operator than on the needs of the tissue. "Anyone," says Dew,[20] "who has watched surgeons in many parts of the world carry out this simple procedure of closing the wound cannot help being struck not only by the diversity of the methods used, but even more by the variability of the healing process." And yet the principles involved are very definite. At the risk of being didactic instead of platitudinous, they are listed below along with specific recommendations.

1. Suture the cut edges to obtain healing in the shortest possible time after the infliction of the wound and not solely for the purpose of securing them as safely as possible.

2. To do this, sutures must not be made the agents for transplanting bacteria into the wound. The clean wound is never sterile. Sutures pick up bacteria (1) by being soaked in a basin previously used to wash instruments coming from the wound; (2) by coming in contact with exposed skin edges, and (3) from repeated handling. The ligature on the spool, for example, repeatedly comes in contact with the blood from the wound and with the hands of the operator, concentrating the bacteria on the unused portion of the suture. "Finger surgery" is an excellent method to move the bacteria about the wound. Ives and Hirschfeld[21] have shown that the majority of postoperative wound infections are caused by bacteria similar to those isolated from the wound at operation.

3. Sutures should not be inserted and tied in such a manner as to create necrotic tissue in which the bacteria may grow. The bite of tissue included in the suture should be small, about 3/8 of an inch when

tied, and tied loosely. The edema that develops in the wound during the first forty-eight hours tightens the sutures further. The tightness required for skin sutures should be used as the guide for the tightness of deep sutures. The redness and infection which develop around the skin suture tied too tightly indicate the effect of the same degree of strangulation on the more easily necrotized muscle and fat. Large tufts of tissues should not be tied off by ligatures. The tuft should not be visible. Excellent wound healing results when healthy cells are placed in contact with healthy cells. Because of the danger of necrosis resulting from tension on the sutures, layers of tissues which will not lie together should not be sutured together. Rather than attempt to approximate tissues under tension by means of sutures, one should release tissues by plastic incisions or not suture them at all. They usually separate again anyway.

4. Traumatic wounds seen eight hours or more after infliction should not be sutured because bacteria have already begun to multiply.

5. Sutures should be used sparingly. They are foreign bodies and, as such, aid in developing a bacterial infection. The common error is to use too much suture material and especially too large sizes. Because of the inability of the tissues to hold larger sutures, there is no need to use a suture larger than No. 0 catgut or its equivalent size of silk. Exceptionally, a larger strand may be needed to set the knot, but not to hold the tissues.

6. In order that sutures may be used sparingly and yet have the greatest mechanical advantages, interrupted sutures should be used with triple throw knots, all tied square. Taylor[22] has shown that such knots provide the greatest security. Tissues having the greatest holding power for the sutures or possessing a mechanical advantage should be sutured—the peritoneum, the fasciae, and the skin. The rest of the tissues do not need to be sutured except under special circumstances. The suture should be of such a type that it pulls at right angles to the tissue fibers and not parallel to them.

7. The clean wound made to drain an infected focus, as for example an appendiceal abscess, should not be contaminated during operation. Laparotomy pads provide protection, and suction should be used to remove the pus. After the peritoneum is closed, the wound is treated as a traumatic wound, freshly contaminated, namely, by irrigation and debridement. Subsequent drainage seeps less between the layers if the drains are placed at one end of the wound. There is no need of the defeatist attitude that all such wounds become infected, and that therefore the layers above the peritoneum should be left open to heal by secondary intention.

8. The skin edges should be everted by the sutures.

9. Attention to details and meticulous care in handling the tissues, instead of haste, cannot be overemphasized. The surgeon may save five or ten minutes in closing the wound rapidly, whereas the patient may lose several weeks and his life may be endangered, fighting an infection.

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By the term sprain is meant an injury which involves minute traumatism only, as the rupture of individual fibers. By the term torn ligaments is meant a more severe injury with abnormal mobility of the joint.

ACUTE MASTITIS

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THE breasts are subject to the same inflammatory vicissitudes that affect other parenchymatous organs. No age is exempt and both sexes may be affected. It is true that the invading pyogenic organisms prefer the lactating gland but not infrequently they find a suitable haven in the non-functioning breast. For instance, we have obtained cultures of Staphylococcus aureus from the discharging nipples of infants. Such a neonatal mastitis represents a suppurative reaction superimposed on a physiologic hypertrophy of the breast tissue due to stimulation of the maternal endocrine glands. These infections are short lived, seldom form abscesses, and usually subside under conservative therapy.

Juvenile or prepubescent mastitis is usually preceded by trauma. Hematomas and devitalized tissues furnish a succulent nidus for wandering pathogens. Figure 1 is a photograph of an 8 year old girl who fell and injured her left breast while suffering from a sore throat. Two days later, the breast became swollen and tender, and the axillary glands were enlarged and "sore." No frank abscess formed but the secretions aspirated from the inflamed matrix contained a streptococcus having the same morphologic and cultural characteristics as those recovered from the throat. Occasionally a prepubertal mastitis may occur as a complication of mumps or as a sequel of an axillary abscess. (Fig. 2.)

Lactation Mastitis. It is common belief that lactation is the most important predisposing factor of acute mastitis.[2] If one considers cracked nipples, trauma, vascular engorgement and stasis of milk as part of the normal process of nursing, then this concept is true.

Much has been written about "caked breasts" and stagnation of milk as being the chief precursors of suppurative mastitis. Sherrick[15] believed retained breast secretions were chemically irritating to the parenchymatous tissues. Keynes[11] maintained such secretions acted as irritants only when reabsorbed. Klahn[10] found those women whose breasts were completely evacuated by means of a pump rather than by nursing did not develop a mastitis. He felt the mechanical evacuation eliminated both stagnation and trauma. Dippel and Johnston[7] pointed out that acute mastitis occurred most frequently during the first two weeks of lactation and it was during this period that stasis of milk and the incidence of "caked breasts" were the highest. It seemed to them the stagnant milk was an excellent pabulum for any lurking pathogens.

While the above arguments have much merit it seems to us they have received undue emphasis. DeLee[6] affirmed that the simple retention of milk seldom terminated in an inflammatory reaction. Williams[16] pointed out that if an artificial stasis of milk were produced by obstructing the orifices of the lactiferous ducts, a suppurative process developed only when pathogenic bacteria were introduced. Actual clinical studies have confirmed this observation.

Mrs. R., housewife, 26 years of age, was referred to the University Hospital with the diagnosis of a "caked breast" associated with a localized abscess. She had successfully nursed her 8 month old child until two days prior to admission, at which time she decided to wean him. In spite of the fact that she produced a copious supply of milk she refused to empty the breasts mechanically. Both mammary glands became engorged, tender and "hot." A milky discharge seeped from the nipples and for twelve hours she suffered excruciating pains. That she was extremely ill was evidenced by a temperature of 103.6°F. and a leucocytosis

of 23,000. It was apparent that the engorgement was due to the retention of breast secretions, but it was felt that the hyperthermia,

Fig. 1. Acute streptococcal juvenile mastitis due to injury of breast while suffering from tonsillitis.

the leucocytosis and the exquisite tenderness resulted from a secondary pyogenic infection. After evacuating the breasts with a pump, 15 c.c. of a contrast medium were introduced into one of the discharging estuaries and a simple roentgenogram taken. The ampulla and all of its communicating lacteals were found to be enormously distended but otherwise normal. (Fig. 3.) Cultures of the aspirated secretion were sterile. This mammographic study clearly demonstrated that the intense mastalgia, the turgidity of the breasts and the systemic reactions were all caused by a retention of normal breast secretions and not by a septic infection.

Mammographic visualizations have also demonstrated that the so-called "caked breast" is not due to an obstructive retention of secretions in the lactiferous tubules but rather to a congestion of the secreting cells themselves. Mammograms have repeatedly shown the ducts leading from "caked" lobules to be patent and on no occasion have secretions been recovered by aspirating the cannulated ducts. (Fig. 4.) The induration and swelling in a breast thus affected are due therefore to the vascular and lymphatic engorgement of the duct walls and to an edema of the epithelial cells which line the acini. These congested cells do not secrete milk. Interestingly enough, these "caked" lobules seldom suppurate unless trauma and infection are superimposed.

Most workers believe that the Staphylococcus aureus is usually the provocative agent in acute mastitis. Occasionally, however, the Staphylococcus albus, streptococci, colon bacilli and mixed infections are encountered. It requires more than the mere presence of bacteria to produce acute mastitis. It has long been known that bacteria may inhabit the lactiferous ducts of an apparently healthy breast. Moon and Gilbert[13] studied the milk of 100 normal lactating mothers and found that in 50 per cent of the cases pathogenic organisms could be recovered from the milk, and yet they did not develop an inflammatory reaction. Apparently the resistance of the local tissues must be reduced by such factors as trauma or stasis before the pathogens can gain a foothold.

The invading organisms gain entrance to the breast by one of four routes: ascension along the ducts, through the lymphatic system, through the blood stream, or by direct extension. Dawson[5] pointed out that in the non-functioning gland the orifices of the ducts are occluded with keratinized plugs of débris, but that with the advent of lactation the ducts become patent, thus affording an easy entrance for any pathogens lurking on the surface of the nipples or in the mouth of the suckling child. In some instances the bacteria which are already inhabiting the lacteals assume pathogenic powers. The high incidence of acute mastitis associated with cracked nipples strongly suggests that the organisms invade the parenchymatous tissues

through the lymphatic channels. Dippel and Johnston[7] firmly believe that acute infections of the mammary gland are much more common after instrumental or surgical deliveries than after normal childbirth. They affirm that the bacteria are carried from the traumatized pelvic organs to the breast by the vascular route.

Fig. 2. Acute mastitis of right breast caused by a retrograde lymphangitis associated with an axillary abscess.

It is apparent that no one agent can be singled out as being the provocative factor in acute mastitis, but that it requires the combined forces of many. Any condition which reduces the resistance of the breast tissues and introduces virulent organisms may perpetrate a suppurative reaction.

SYMPTOMS

The symptoms of acute mastitis are rather definite and not difficult to recognize. At first the affected lobules become swollen, tense, and tender. The excruciating mastalgia makes nursing a painful ordeal and results in an incomplete emptying of the milk ducts. The skin assumes a dusky, brawny color and the resulting edema accentuates the pitting of the skin, making the little depressions seem more widely separated than normally. If the acute mastitis does not respond to conservative therapy within three or four days, the induration progresses to the stage of liquefaction and abscess formation.

It is most difficult to determine when an inflammatory process has progressed to the state of abscess formation and yet such information is essential to correct therapy. Usually the acute mastitis becomes localized, the induration increases and the patient acquires a septic appearance. The subareolar and subcutaneous varieties soon point, and fluctuation can be easily demonstrated, but in the deep-seated intramammary and retromammary types the induration becomes so pronounced that it completely obscures all semblance of fluctuation and may be mistaken for a solid tumor. In rare instances, the abscess may communicate with the ducts and discharge its purulent contents from the nipple.

Fig. 3. A mammogram of an enormously dilated ampulla and its communicating radicle caused by retention of breast secretions.

It is of vital importance that suppurative lesions should be differentiated from inflammatory carcinoma. Kilgore[12] found that 25 per cent of all cancers occurring in the lactating breast were discovered during the early months of lactation, many during the first four weeks. Under such circum-

stances, it was quite natural to assume that the malignant neoplasms were merely inflammatory processes rather than true

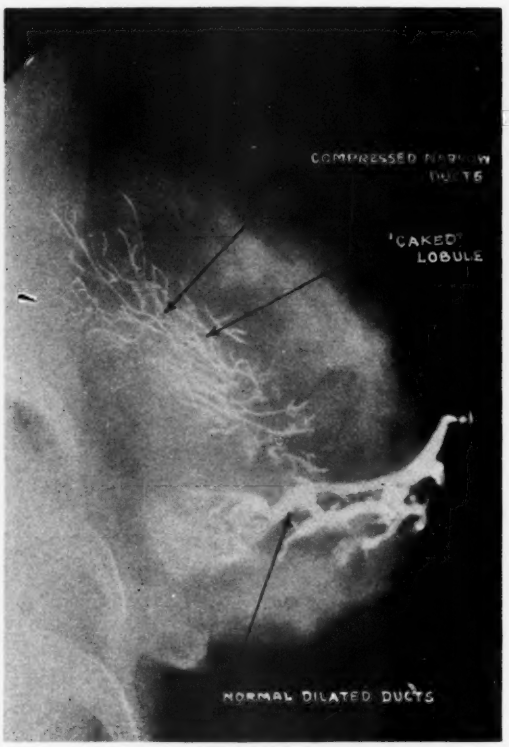

FIG. 4. Observe the large dilated ducts of normal breast lobule as compared to the compressed narrowed lumen of those of the "caked lobule." All ducts are patent.

cancers. In some instances, several months passed before a correct diagnosis was made, and by that time the carcinoma was so extensive that only palliation could be offered to the patient. Aspirational and exploratory biopsies may be necessary to make a correct diagnosis.

TREATMENT

Prophylactic Therapy. It is much easier to prevent abscesses from forming than it is to cure them. Particular attention should be paid to the nipple during the last two months of pregnancy in order to prepare it for the ordeal of nursing. A gentle stripping massage not only develops the fibrous and muscular structures, but it makes the nipples stand more erect, thus making nursing much easier. Daily inunctions with hardening solutions render them less susceptible to the trauma and maceration of frequent nursing.

It is during the period of engorgement

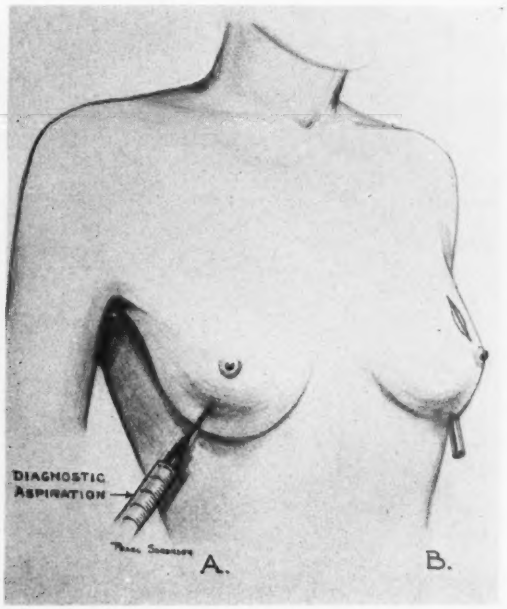

FIG. 5. A, diagnostic aspiration of an inflammatory mass to determine the presence of pus. B, establishing dependent drainage in an abscess which had "pointed" above the nipple.

that vigilance is of paramount importance. Cracked and fissured nipples require immediate attention, as painful nursing inevitably leads to incomplete evacuation of the breast with subsequent stagnation and possible infection. The use of hot boracic acid compresses, nipple shields, breast pumps, ultraviolet light and short wave diathermy will do much to expedite the healing of sore nipples. If the breast becomes "caked," the concern should not be for the affected lobule but for the unaffected segments. Seldom does the "caked" lobule suppurate, for it is a congestive and not an inflammatory process. It is dangerous only in that the associated mastalgia interferes with complete evacuation of the uninvolved lobules. If nursing becomes so painful that complete emptying is not obtained, then a breast pump should be employed. Massage, stripping the nipple, or too forceful attempts to evacuate the distended areas are detrimental. The resulting trauma accentuates the congestion, produces small regional hematomas which

furnish an inviting place for bacterial growth.

Even in the presence of acute inflammatory reactions, conservative therapy will bear fruit, for not every inflammatory mass requires surgical drainage. In fact, most of them can be aborted before they reach the point of suppuration. All nursing should be suspended as the resulting trauma aggravates the lesion and the ingestion of contaminated milk might prove harmful to the nursling. In mild infections the breast pump is effective in completely evacuating the ducts. If, however, the entire breast is involved, all attempts, both real and artificial, to empty the breast should be prohibited. Hot fomentations and cold packs have both proved effective, but the former seem to possess greater powers of analgesia. We have found that short wave diathermy, given four or five times a day, relieves the congestion and mitigates the discomfort. This dry heat not only prevents the maceration of the skin which may accompany the frequent use of moist compresses but it also deposits the heat within the deeper tissues where it is most effective.

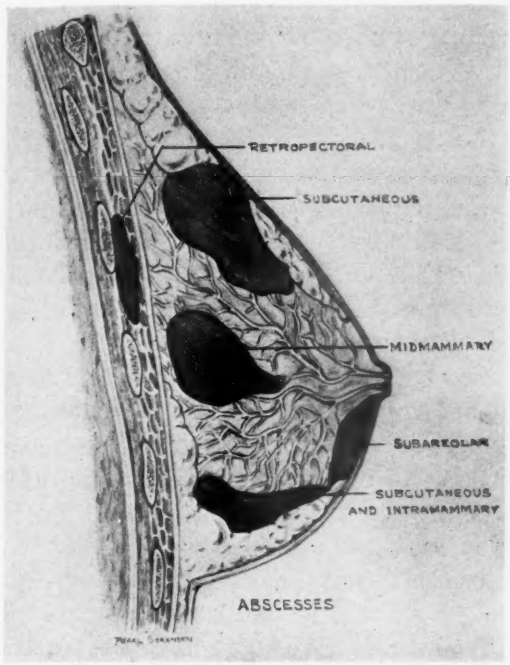

Fig. 6. Various types and locations of mammary abscesses.

Irradiation possesses definite curative properties in the early non-suppurative mastitis, if used correctly. Hunt[9] maintains that it not only arrests the progress of the infection but accelerates the resolution of the inflammatory mass.

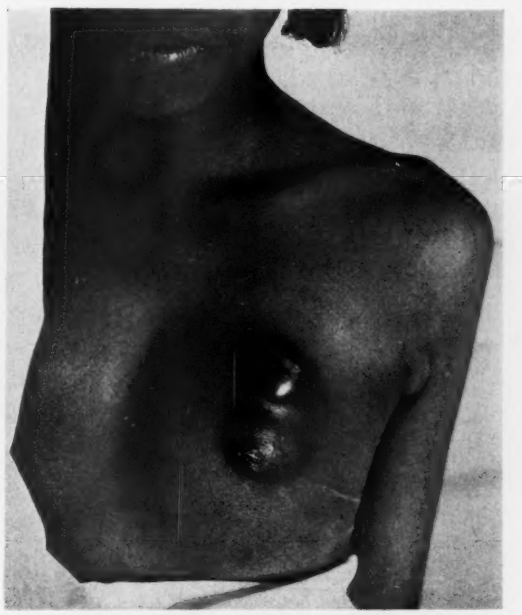

Fig. 7. A persistent sinus and milk fistula caused by severing the milk ducts while draining an intramammary abscess.

Management of the Breast Abscess

Frank suppuration calls for immediate drainage. Procrastination merely permits the infectious process to destroy adjacent tissues and convert a simple abscess into an extensive multilocular lesion. It may be extremely difficult to determine when an inflammatory tumor has undergone suppuration. It is common practice to wait until fluctuation can be demonstrated, or until the abscess points, before resorting to surgical interference. Such a practice is certainly not without danger, for in the presence of intramammary and retromammary abscesses, one is not always able to demonstrate fluctuation. Whenever there is doubt, the aspirating needle is enlightening. (Fig. 5A.) If pus is encountered, the abscess should be drained regardless of whether fluctuation can or cannot be demonstrated. There should be no hesi-

tancy in performing diagnostic aspirations, for a single puncture does not disseminate the infection and immediate drainage is much better than expectant treatment.

The surgical management cannot be standardized as it varies with the size, location and extent of the abscess and the functional status of the mammary gland. (Fig. 6.)

Subareolar abscesses are usually superficial and, as the infection follows along the larger ducts, it naturally points to the surface. Being small and involving only the subcutaneous tissues, these abscesses can be drained effectively by a small circumareolar incision. It should not extend below the dermis for fear of severing the large ductal ampullae which may result in an annoying milk fistula. Fig. 7.) The abscess proper is opened by inserting a blunt forceps into the inflammatory mass. It is extremely important to determine whether the subareolar abscess communicates with a larger intramammary pocket of pus as the latter requires more radical drainage.

Subcutaneous abscesses, when they occur singly, are easily recognized and can be drained effectively by radial incisions. They offer no problem unless they are of the "dumb-bell" type with an underlying midmammary abscess.

Intramammary abscesses present a more complex problem. The suppurative process becomes rather extensive before it spreads to the overlying skin, hence there is considerable destruction of the parenchymatous tissue. It is a great temptation to open such an abscess over its presenting point, but unfortunately this does not always give adequate drainage. Puddling of secretions with maceration of adjacent tissues prolongs the time required for healing and favors the formation of chronic sinuses.

Whether the abscess ruptures spontaneously or is opened over its presenting surface, an exploring finger should be introduced to break up all pockets and convert the multilocular abscess into a single cavity. If gently and cautiously executed, such a maneuver is very effective. Auchincloss[1] maintains that if great care is exercised in breaking these friable partitions, much good can be accomplished. He insists that the finger should be carried radially, or parallel to the ducts, so that it will not rupture them. If one encounters strong bands or heavy septa, they should not be avulsed or broken as they may be large blood vessels, milk ducts, or healthy fibrous tissue trabeculae. Preservation of these structures facilitates healing; their destruction merely favors the spread of the invading pathogens. Gentleness always pays good dividends! While exploring the abscess one should determine its extent and depth, and if the external ostium does not provide adequate drainage, a counter-incision should be made and a large rubber tissue drain inserted. (Fig. 5B.)

Battle and Bailey[3] emphasize that there need be no hesitancy in placing the drains through normal tissue. Bohler[4] agrees with them and advocates drainage of the midmammary abscesses by making a large dependent incision in the inframammary fold, carrying this up behind the breast until the dependent portion of the abscess is reached. It seems that such a plan needlessly exposes healthy tissue to contamination. Hobbs[8] appreciated this and attempted to minimize the insult by making a stab incision into the abscess and inserting a fenestrated rubber tube. Riché and Morgue-Molines[14] modified the Hobbs treatment by attempting repeated aspirations of the abscess with small needles. This method is effective if the inflammatory process is small and superficial, but if the needle has to penetrate much fatty tissue a secondary infection inevitably follows. Again, the contents of the abscess may be so viscid that they cannot be evacuated through a small needle.

After studying these problems, we have developed a simple but effective method of treating the medium size, uncomplicated intramammary and retromammary abscess. Not only is the simplicity of this method appealing, but the fact that it can be used for ambulatory patients enhances

its usefulness. The first step consists in aspirating the inflammatory mass to determine whether it has progressed to the stage of suppuration. (Fig. 5.) If so, the location of the abscess is studied and a point selected which will give dependent drainage. If possible this should be along the thoracomammary line. The skin and underlying normal tissues are infiltrated with novocaine and an incision 1 cm. long is made through the dermis only. A sharp-pointed trocar is plunged through the anesthetized area into the most dependent portion of the abscess cavity. (Fig. 8A.) After the obturator is withdrawn, a fenestrated catheter is inserted through the metal sheath and anchored to the skin with a dermal suture. (Fig. 8B.) The cavity is thoroughly lavaged with Dakin's solution. This primary irrigation is essential as it removes the inspissated pus and necrotic débris which might clog the catheter and inhibit proper drainage.

After the abscess has been irrigated thoroughly, the skin is covered with protective vaseline gauze and large absorptive fluffs are placed around the drainage catheter. A sponge pressure dressing is applied in such a manner that it immobilizes the breast and collapses the abscess cavity. (Fig. 9.) The drain effectively removes any secretions which may form and the contiguous walls of the cavity fuse and heal. The pressure dressing should be applied in such a way that the absorptive fluffs can be readily removed when they

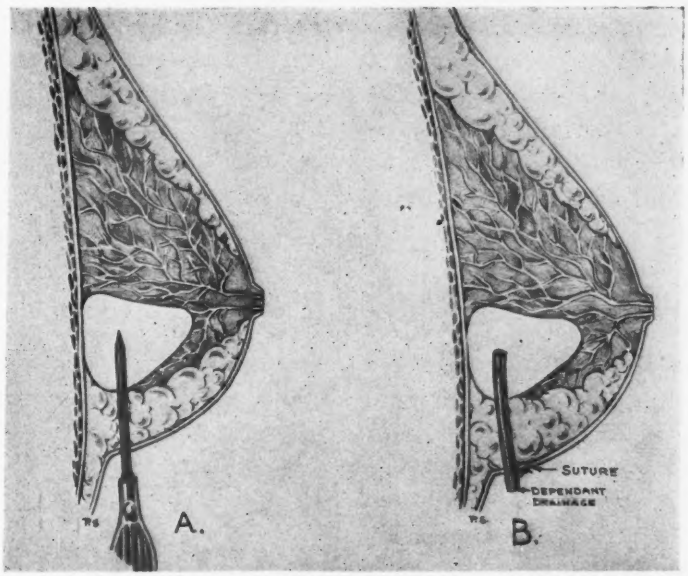

Fig. 8. A, insertion of the trocar into the abscess cavity. B, a fenestrated rubber catheter is inserted so as to afford dependent drainage.

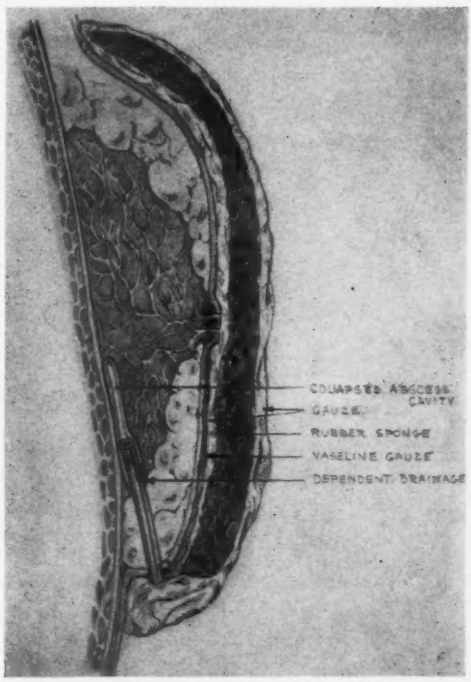

Fig. 9. Pressure sponge dressing.

become soiled. This prevents maceration of the skin.

The simplicity of this method and its effectiveness are most pleasing, for at least 95 per cent of all midmammary and rectromammary abscesses can be so treated. Unfortunately, however, it does have definite limitations. If the entire matrix is involved in a diffuse cellulitis or if there are multiple abscesses, more radical treatment, such as through and through drainage, may be required.

Regardless of the type of drainage employed, care must be taken to leave the drains in place until the deep abscesses have healed. A common error is to remove the drains just as soon as the discharge decreases, but the deep pockets may not be obliterated and if the ostium closes over, the abscess reforms. Residual infections and recurrent abscesses mean that the primary inflammation has not completely subsided. The average case requires drainage and irrigation for at least seven to ten days, and it should be observed closely for early signs of recollecting pus.

It is imperative that general systemic measures be employed to reinforce the surgical treatment. If possible, these patients should have complete rest, liberal diets high in caloric and vitaminic content, and frequent applications of short wave diathermy.

The breasts have great recuperative powers and if given a chance the destroyed tissues will be replaced by normal glandular substance. Fortunately, the diseased breast will assume its regular functions with the next lactation and as a rule there is only a slight decrease in the amount of milk which an affected gland will produce. The infrequency with which mammary abscesses are encountered is a tribute to the intelligent type of obstetrics being practiced today.

SUMMARY

1. The etiology, symptomatology and diagnosis of acute mastitis and breast abscesses are discussed.

2. A "caked" breast is not an acute inflammatory process but rather one of congestion.

3. The use of an aspirating needle is informative in differentiating the "caked" breast and the simple inflammatory mastitis from the suppurative variety.

4. Acute mastitis usually responds to conservative therapy and seldom terminates in suppuration.

5. Adequate surgical drainage is essential in the treatment of all types of mammary abscesses.

6. A simple but effective method of draining mid-mammary and retromammary abscesses by means of a trocar and catheter is described.

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A REGIME FOR CONTROLLING PAIN IN FAR ADVANCED CANCER PATIENTS*

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MANY cancer patients require pain relieving drugs for several weeks or months. Sometimes narcotics are given in increasing doses, so that the continued excitation produced by the drug makes the patient more uncomfortable than the pain of the disease. In other cases insufficient sedation is given, and long weeks of suffering are endured—much of which might have been prevented.

The following régime has been evolved over a period of five years, during which time we have had 700 cancer patients, practically all of them in far advanced stages, under our care. The nursing unit is small, so that individual reactions and needs could be closely watched, and there was no need for routinization. The drugs discussed are only those we have used personally. Other common drugs undoubtedly have a field of usefulness in these cases, but either we have not found them necessary, they are too expensive, or we did not know of them.

GENERAL NURSING CARE

A hospital bed, frequent changes of linen, avoidance of irritation of bony prominences, bodily warmth, simple care of the bowels, nourishing food (perhaps high protein content, adequate vitamin B because of the wasting of the disease) will make many patients comfortable. We mention this only because we have seen so many patients, who have required pain relieving drugs at home, become comfortable and require very little medication after they have had proper nursing care.

"If a cancer patient can get five to six hours sleep, and can take his food during the day, he is not suffering intolerable pain and the drug (morphine) need not be increased." We have roughly followed this standard, laid down by Wild[1] of London. Though some authorities feel that there is no reason for sparing the use of morphine in these cases, we try whenever possible to limit the increase in narcotics, if the patient can possibly be kept comfortable by milder drugs.

SEDATIVES AND ANALGESICS

Sedatives presumably act on the higher brain synapses, while the analgesics, because they decrease general sensitiveness of the body without depressing mental activity, are supposed to act on the lower centers, e.g., the thalamus. This is an explanation for the synergistic action of these two sets of drugs (Grabfield[2]).

Sedatives (*Soporifics*). Alcohol is perhaps the oldest hypnotic, dating back to early antiquity (Hjorst[3]). Cannabis indica (Indian hemp) opium, hyoscyamus, valerian and other medicinal herbs were known to the ancients. Later, came opium alkaloids. Next came naturally occurring inorganic chemicals: first bromine salts (potassium bromide, later sodium bromide), then magnesium compounds. Then came synthetic chemicals, chiefly inorganic: chloroform 100 years ago, and shortly afterwards its derivative chloral (1869), the first modern hypnotic, which swept into such immediate popularity that within two years 200 articles were written about it, and it was actually manufactured in tons. One chemist wrote that he produced and sold one half ton each week (Hjorst[3]). Paraldehyde, urethanes, methanes (trional, sulphonal) date from about 1880 to 1890.

The first *barbiturate* (barbital) was introduced in 1903 by Fischer under the

* From the Mercy Hall Tumor Clinic and Hospital.

trade-name of veronal. Pharmacologic and clinical research since then has been concerned chiefly with an increasing number of commercially exploited barbiturates. Older drugs have lost popularity because of toxicity, or unpleasant properties, but there is much uncritical acceptance of newer remedies, and the virtues of some of the older drugs are being forgotten.

Alcohol, in addition to its hypnotic action, is a mild analgesic. It also produces peripheral dilatation and a sense of warmth and is an easily assimilated food (whiskey 2 or 3 drams every three or four hours, or 2 ounces of port wine at bed time). Wild[1] states that it has a synergistic action reinforcing other anodynes.

Bromides are the mildest sedative, useful for "pains all over," "hypersensitiveness." *Chloral hydrate* has fallen into disuse because of the objectionable taste and the danger of heart failure in large doses. Nevertheless it is still one of our most useful sedatives (Hjorst[3]), and in small doses there is little if any danger of heart failure (Grabfield[2]). In the compound elixir, chloral and potassium bromide, 1 dram contains 15 gr. each of chloral hydrate and potassium bromide plus extract of hyoscyamus gr. $\frac{1}{8}$.

Acetylsalicylic acid and aminopyrine (see analgesics) are sedative in addition to being analgesics (Fantus[4]). *Chloretone* (chlorbutanol), a chloral derivative, is locally anesthetic—to the gastric mucosa (gr. 5 to 20). It is a mildly useful sedative in nausea and vomiting (Beckman[5]). *Carbamides* combine ethyl, bromide and urea radicals. They possess greater sedation than bromides—standing midway between bromides and barbiturates (Carbromal, adalin, or bromural, gr. 10 to 20).

Barbiturates are derivatives of malonyl urea (barbituric acid), representing a large variety of combinations of alkyl, such as ethyl, groups plus malonyl urea nucleus (Lundy,[6a] Leake[6b]). Though some authorities differ, most consider that they are sedative only, and have no analgesic action except in very large doses which produce deep narcosis. (Wagner[7]). Barbital, the first synthesized, contains two ethyl groups plus malonyl urea. *Phenobarbital* (luminal) is a phenyl ethyl urea derivative. Barbital and luminal are just as useful in these cases as the more complex proprietary barbiturates which are extensively advertised and they cost about one-thirtieth as much.

Hyoscine is useful for very excitable patients. There is considerable individual variation in the dosage required. Sometimes gr. $\frac{1}{400}$ to $\frac{1}{600}$ is ample, but, on occasion, as much as $\frac{1}{50}$ gr. can be prescribed.

Analgesics. For pain relief we first use the coal tar drugs, all of which have analgesic action. They are also circulatory depressants. It is a general rule that if small doses do not relieve, larger ones are ineffective and may be toxic so that there is no advantage in increasing the dose. There are two groups: the analgesic antipyretics (acetanilid, acetphenetidin and aminopyrine) and the antirheumatic antipyretics (acetylsalcilic acid), so-called because they are thought to lessen the degree of inflammatory reaction in the fibrositis of rheumatic pains.[8]

Of the first group, acetanilid (gr. 3) is the least expensive, and though not used very frequently today, is "perhaps as safe as any of them" (Fantus[4a]). The danger of methemoglobinemia can be watched for. Acetphenetidin (phenacetin) gr. 5 is routinely prescribed. Aminopyrine, (pyramidon) gr. $1\frac{1}{2}$ to 5 has three times the analgesic power of either acetanilid or acetphenetidin. Only a very occasional patient is sensitive to it, so that the danger of neutropenia is not great, but the white blood count should be observed occasionally, especially in sensitive (allergic) individuals (Watkins[9]).

Of the antirheumatic antipyretics acetylsalycilic acid (gr. 5 to 10) is probably the most useful analgesic we possess. Atropine, belladonna, and extract of hyoscyamus are prescribed with it to allay sweating and gastric irritation; and caffeine to avoid circulatory depression.

Combinations of these two groups of coal tar derivatives, the analgesics and the antirheumatics are very useful, for one obtains the synergistic action of two analgesics. Many extensively used and exploited popular commercial tablets contain this combination.

COMPOUND ASPIRIN TABLET

	Gr.
Acetylsalicylic acid	3½
Acetphenetidin	2⅓
Extract of hyoscyamus	⅙

	Gr.
Acetylsalicylic acid	3½
Acetphenetidin	2½
Caffeine	½

Next, we add a sedative to the coal tar analgesic. Barbiturates are the most popular sedatives in these combinations today. "The barbiturate diminishes the patient's anticipation of pain, renders the patient more amenable to the analgesic action of the antipyretic." It does not reinforce the analgesic except in this fashion.

Popular combinations of barbiturates and coal tar drugs are:

	Gr.
Aminopyrine	3 to 4
Phenobarbital	½ to 1½
Compound Aspirin Tablet with phenobarital	¼
Barbital	4
Acetanilid	1½

There is no satisfactory evidence that commercial mixtures of proprietary barbiturates and aminopyrine are any more valuable than these mixtures.

A Warning. The analgesic is eliminated faster than the barbiturate. Watch for cumulative action of the barbiturate if given over a long period of time. Toxic symptoms from long continued moderate doses are: *mental*—confusion, uncertainty, defects in attention and memory, diplopia; *skin*—urticaria, itching, scarlatiniform rash; *general*—anorexia, nausea, diarrhea, epigastric pain, thick speech, etc. (Lundy,[6a] Wagner[7]).

We have kept many patients comfortable until near the end on the above prescriptions. When they fail to give relief, we then resort to the opiates.

OPIATES

First, we use codeine, gr. ¼, ½ or 1. Larger doses of codeine cause restlessness and excitement. Codeine is a weak narcotic, perhaps one-tenth as potent as morphine (Fantus[4a]).

Codeine may be added to the above prescriptions, as follows:

		Gr.
*A.**	Acetylsalicylic acid	2
	Sodium bicarbonate	3
	Atropine sulfate	1/150
	Codeine sulfate	½
		Gr.
B.	Acetylsalicylic acid	3½
	Acetphenetidin	2½
	Caffeine	½
	Codeine	⅛, ¼ or ½*
		Gr.
C.†*	Prescription *B.* but add:	
	Codeine	1
	Phenobarbital	1

* Tablet #1, 2, or 3.

† Kaplan.[10]

The tablet can also be given orally, and the codeine by hypodermic administration. Dilaudid gr. 1/48 is a good substitute here. It is cheaper than codeine and a more powerful analgesic. First give tablets during the day, and injections at night, or during rainy weather.

Some patients demand an injection. We have kept many comfortable by one of the above tablets plus injections of sterile saline solution—with perhaps stronger medication at night. If aspirin relieves by day, a milder drug than morphine will relieve at night (Daland[11]).

When the patient requires stronger narcotics, at first we give an occasional subcutaneous injection of morphine (gr. ⅙ to ¼), or dilaudid gr. 1/32 to 1/20, or pantopon gr. ⅓. At this period suppositories of opium or dilaudid may be useful—they last longer (eight to ten hours) and parenteral administration is not needed.

But it is important at this time to search for other methods of relieving pain and discomfort. These depend largely on individual circumstances, but may include any of the following: control of anemia, dehydration, improvement of appetite; treatment of vitamin B_1 deficiency; care and

cleansing of wounds; drainage of cellulitis and abscesses; short circuiting alimentary canal operations or operations for similar threatened occlusion of the respiratory or urinary tract; treatment of urinary sepsis; suction drainage of urinary fistulas; alcohol intraspinal injection; peripheral nerve injection; cordotomy; *x*-ray therapy—especially for spinal mastastases.[12]

A few cases will illustrate:

Case I. An old man, age 78, had carcinoma of the left side of the mouth originating in the buccal mucosa near the ascending ramus of the mandible. Severe pain gradually developed in the left side of the face. The cheek became more swollen. Morphine injections every three to four hours were required.

Alcohol injection of the fifth nerve was about to be done, when an abscess broke beneath the mandible, with considerable relief.

Case II. A man, age 68, had carcinoma of the bladder, and suffered from frequency, dysuria, and pain localized inside the rectum. He required opium or dilaudid suppositories three times daily. Two intraspinal injections of absolute alcohol, two weeks apart, relieved him so that there was frequency, but no dysuria, and the pain in the rectum was a mild "burning" coming occasionally.

Case III. A colored woman had carcinoma of the cervix which had ulcerated into the bladder. Codeine and aspirin capsules every four or five hours were required for the discomfort and soreness caused by the discharges. Continuous suction, with a gauze wick in the vagina (Stedman pump, Hendrikson catheter)[13] kept her dry—the inflammation subsided, and she required only an occasional mild sedative at night.

Of 100 patients cared for at Mercy Hall until exitus, which included cancer of all types, with three months minimum observation,

47 per cent required only coal tar drugs and sedatives.
33 per cent required narcotics the final two weeks only.
20 per cent required narcotics for a longer period of time.*

* Daland[11] likewise commented on the small amount of morphine and codeine used at the Massachusetts State Cancer Institute at Pondville. An average of 3½ gr. of morphine per patient per month was all that was required, and this included operative care.

As morphine is stepped up, in the 20 per cent who need it, it is our practice to intersperse the doses as much as possible with the sedative and analgesic prescriptions above. Toward the end, in some cases, powerful sedatives are needed. Hyoscine (scopolamine) is used clinically for acute mania and excitement. It is frequently useful in the terminal stages, producing deep narcosis with peaceful oblivion. Occasionally there is idiosyncracy; then it causes excitement.

Hyoscine and morphine have strong synergistic action. The familiar H.M.C. tablet contains the two drugs plus cactine, an old cardiac stimulant.

HMC	#1, Gr.	#2, Gr.
Hyoscine	1/200	1/100
Morphine	1/8	1/4
Cactine	1/120	1/60

Schlesinger's solution is also a powerful synergistic combination. Though it has the advantage of being oral drops, we have not made extensive use of it because in our experience it frequently causes restlessness and excitement after use for a short time.

		10 minims =
Scopolamine HBR.	.005	1/50 gr.
Morphine	.8	1/3 gr.
Dionin	.4	1/6 gr.
Water q.s.	20.0	

Halsted used morphine and dionin orally (courtesy Dr. E. R. Arn, Dayton, Ohio).

Morphine	
Dionin	āā gr. viii
Aqua	q.s. ℥ii

Dose: 5 drops on sugar 2 or 3 times daily. Increase the dose as required.

The combination of morphine and chloral, the familiar "knockout drops" of the underworld, is simple, and again probably not used as frequently as it might be.

Morphine sulfate	0.15	Gm.
Chloral hydrate	15	Gm.
Fluidextract of Glycyrrhiza	30	Gm.
Syrup orange q.s.	60	c.c. drams 1 (Fantus[4])

Hyoscine may be added to this mixture.

Another combination we have found useful is trivalate, a powerful analgesic and sedative, which may have a long action, as much as twenty-four hours in some cases. It produces some euphoria also.

	Gr.
Caffeine valerate.....	1/17
Cocaine.....	1/12—1 ampule
Morphine valerate.....	3/0

Cobra snake venom is a complex alkaloid which has a slower action than morphine, but it is more prolonged. One-half to one ampule every day, or every other day may keep a patient comfortable who otherwise would require an opiate every three to four hours. Its action is quite variable and unpredictable, however.

DISADVANTAGES OF MORPHINE

The disadvantages of prolonged morphine administration which we have encountered are: (1) it is habit forming—tolerance may be gained rapidly—within two to three weeks; (2) constipation is universal; (3) loss of appetite, nausea, vomiting are frequent; (4) there is euphoria—which, however is not always a disadvantage, but the patient is irritable, morose, depressed, nauseated, constipated. Increasing doses are necessary to control the discomfort, much of which is caused by the drug itself.

Dilaudid, although its action is similar, and prolonged usage does produce habit, has certain advantages over morphine in cancer patients. The appetite is retained. This is very important, for patients have less discomfort, feel better, therefore fewer drugs are required. Constipation is less frequent and less severe and hypnosis is less marked. This is better if the patient is ambulant at all. If hypnosis is desired, a barbiturate is added.

TREATMENT OF MORPHINE ADDICTION

A craving for morphine can develop within ten days after starting its use, but it usually takes three to four weeks to manifest itself. Often patients are given a box of morphine tablets to keep next to the bed at home. Sometimes in general hospitals hypodermic injections of morphine are given freely and uncritically.

As stated earlier, we believe that it is distinctly worthwhile to take the patient off heavy morphine doses if it is at all possible to keep him comfortable otherwise. In cancer patients, addiction is due to the use of the drug for relief of physical pain and for this reason the habit is easier to break than in psychotic or constitutionally inferior groups, provided pain is relieved.

The methods of morphine withdrawal are:

1. Gradual daily reduction of morphine. Secure a good night's rest with phenobarbital, amytal, chloral hydrate, hyoscine. Gradually supplant morphine with codeine, aspirin, etc., as tolerated. Ashworth[14] states that if morphine is supplanted with pantopon, the change to codeine is easier. Use high caloric diet and large quantities of fluids. This treatment is sufficient for many of these cases.

2. Insulin may be used (units 10 to 12) in conjunction with the above gradual withdrawal, or morphine can be withdrawn completely, and insulin, units 10 to 30 substituted according to patient's discomfort and craving, increasing the dose (every two to four hours) until symptoms are relieved. One hundred sixty units or more may be given in twenty-four hours. Let the patient have a mild shock before giving food or sugar. Continue high dosage of insulin three days to one week, then as symptoms disappear, gradually discontinue the insulin, provided appetite and food intake are good. When the patient is taking small amounts of the drug, it can be withdrawn abruptly (Crowley[15]). Though the mechanism of the sparing action of insulin on morphine is not certain, it is believed that the adrenal function of carbohydrate metabolism is interfered with in morphinism (Piker, Crowley[15] and others).

3. Complete withdrawal, keeping patient somnolent forty-eight to seventy-two hours with sodium amytal gr. 3 to 6 every six to eight hours. Then give codeine,

aspirin, etc., sparingly for pain. We have found this method very useful in these cases. One must watch for barbiturate circulatory depression, especially in debilitated individuals.

4. The scopolamine—pilocarpine treatment described by Klingman and Everts.[16] We have not used this method. The patient is kept asleep for forty-eight hours with scopolamine gr. $\frac{1}{200}$ given every one or two hours. This is then "washed out" with pilocarpine nitrate, gr. $\frac{1}{8}$ for five hours.

When withdrawing morphine, one must be on the alert for withdrawal symptoms. Watch for restlessness, apprehension, vague discomfort, loss of appetite, yawning, generalized aches, pains, cramps. It is often difficult to tell whether the patient has real physical pain. If he is unable to localize his symptoms, will not take an oral tablet and insists on a needle, if medication relieves three hours by the clock and he then demands more at regular intervals, or if he will sleep for hours on an injection of physiologic salt solution plus 5 grains of aspirin, then "pain" is probably morphine craving.

Severer symptoms of morphine withdrawal are: tremors, perspiration, twitching, vomiting, diarrhea, palpitation. Usually, withdrawal symptoms subside if the patient can go three or four days without morphine.

SUMMARY

A regime for pain relief in far advanced cancer is described. Simple sedatives, coal tar analgesics, mild then stronger analgesics are used in increasing scale.

The importance of pharmacologic action, individualization of drug and patient, danger of overdosage, control of morphine addiction, consideration of methods other than drugs to relieve pain are emphasized.

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ANORECTAL ACTINOMYCOSIS*

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ACTINOMYCOSIS, although commonly found in other parts of the body, rarely occurs in association with anorectal lesions. Illich, who reviewed 421 cases of actinomycosis in 1892, did not record any case in which the anorectal region was involved.

Sanford and Voelker studied 670 cases in 1925. The gluteal region was involved in five cases, the perirectal region in five cases, the scrotum in four cases, and the thigh, ovary, Fallopian tubes, both ovaries and Fallopian tubes, kidney, bladder, testes and penis, in one case each.

ETIOLOGY

Although this disease is most frequently found among farmers, persons in all walks of life are susceptible. It is more common among males than among females. Several reasons for this have been considered: One is that men are more prone to exposure since most of the men who are infected are farmers; another reason is that mouth hygiene is not as good in men as it is among women. According to Sanford and Voelker, 80 per cent of those who have actinomycosis are males. It is distributed widely in the United States and is especially prevalent in the upper part of the Mississippi Valley and in the northwestern portion of this country. It is found at all ages, but most frequently affects young adults. Some observers say that Actinomyces bovis has not been found in persons free of the disease or elsewhere in nature. An organism simulating this one may inhabit the mouths of healthy persons but it is not believed to be pathogenic. In the collected series of cases of anorectal actinomycosis the youngest patient was a girl aged 14 years, and the oldest a man aged 72.

MODE OF INFECTION IN MAN

The mode of infection in man is disputed. Some say that the infection occurs through the agency of hay, straw, grass, and clover. Others contend that such substances furnish only the trauma which permits organisms, namely, actinomycetes which are normally present in the tonsillar crypts, carious teeth, and other regions, to display their pathogenic properties (Wright and Lord). Schlegel said that "actinomyces are found in the body under normal conditions, but they do not possess sufficient virulence to produce trouble." He claimed that the disease usually begins as a fresh introduction of fungi. According to Kazda, the fungus is not able to produce disease unless there is local injury of tissue. Berestnew was able to isolate the actinomycetes from straw, grass and hay. New and Figi expressed the opinion that the prevalence of the disease indicates abundant organisms on the vegetation. Direct contagion from an infected animal to man or from man to man has not been definitely proved. Instances have been reported in which one person has bitten another who in turn has become ill with actinomycosis at the site of the bite. Naeslund, a Swedish bacteriologist, working in Upsala in 1925 and 1926, succeeded in isolating both the aerobic and anaerobic forms of actinomycetes from the human mouth. He claims that some of his anaerobic strains are identical with Actinomyces bovis which were obtained from human beings who had actinomycosis.

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Minges, in 1892, obtained "sulfur granules" from a patient and was able to infect a white rat by planting a single colony in the peritoneal cavity. This rat lived for eighteen months. Potassium iodide was fed in the milk. Later a nodule was noted on the jaw of the rat. Usually, however, attempts to inoculate laboratory animals are unsuccessful.

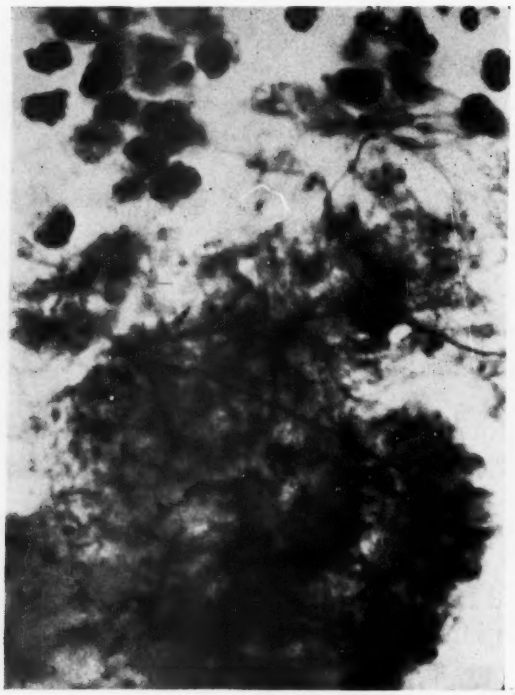

FIG. 1. Actinomycotic lesion in which the mycelia are shown very well; specimen stained with Gram's stain (× 1150).

In cases of anorectal actinomycosis the organism (Fig. 1) usually is admitted through the mouth and migrates down the intestinal tract with the food until it reaches a region where stasis occurs. According to Hinglais, this commonly happens in the cecum and rectum. A small abrasion in the mucous membrane provides a portal of entry. The stomach and upper part of the intestinal canal usually are not involved. This has been explained on the basis that the organism does not grow well in an acid medium. The fungus may enter an abrasion of the perianal skin or it may enter infected or ulcerated crypts or other lesions at the anorectal outlet. In such instances it is often possible to learn from the history that the patient has used grass, straw or hay to cleanse himself following defecation.

LESIONS OF BONE ASSOCIATED WITH ANORECTAL ACTINOMYCOSIS

Primary involvement of bone in man is rarely if ever found and when observed it usually is the result of extension from an adjacent process. This is in contrast to the disease in cattle in which the jaw bone is the most frequent lesion. Langenbeck is said to have been the first one to observe the actinomycetes in a chronic disease of the vertebrae. This, however, is doubted by many observers today. Sanford and Magath expressed the opinion that the actinomycetes usually do not involve the bony structures of the human being. In the case reported by Perry there was destruction of the sacrum and in the one I am reporting there was involvement of the left side of the sacrum when the patient was seen in January, 1935. Roentgenographic studies of the pelvis revealed some irregularity of the inferior left aspect of the last segments of the sacrum. (Fig. 2.) In May, 1935, stereoscopic studies of the anteroposterior and lateral roentgenograms of the sacrum did not reveal any apparent change in the irregularity previously seen. Since that time, with improvement in the granulomatous reaction, the contour of the sacrum apparently has become more smooth and regular in outline, as demonstrated by the roentgenographic studies made in December, 1937. (Fig. 3.) This leads one to suspect that the lesions of bone accompanying actinomycosis in the human being may be the result of an osteomyelitis caused by secondary infection. When the actinomycetes are found in bone they may be coincidental. With arrest of the disease the lesion of bone appears to subside. Further study is necessary to clear up this observation.

The paucity of reports of anorectal actinomycosis in the literature and the finding of only one instance of this condi-

tion among all of the cases in which proctoscopic examinations have been performed at The Mayo Clinic support the idea that the anorectal region is rarely involved. I was able to find only one recorded case of anorectal actinomycosis in this country,[25] but on reviewing the foreign literature I found reports of sixteen cases[1,2,4,6,7,14,18,24–29,33,36] in which the condition might be considered to be anorectal actinomycosis, although the description was not always clear and the presence of primary actinomycosis of the anorectal type was not always established.

Fig. 2. Irregularity of inferior left aspect of the last segments of the sacrum; roentgenogram was made in January, 1935.

Fig. 3. Roentgenogram of same pelvis as shown in Figure 2. This roentgenogram, which was made in December, 1937, shows that the inferior left aspect of the sacrum is more regular in outline and smoother than it was in January, 1935.

REPORT OF CASE

A man, aged 70 years, who was the manager of an oil company, came to the clinic, October 9, 1933, complaining of multiple fistulas around the anus. There had not been any evidence of tuberculosis. He had been in the habit of chewing clover. On occasions, while he had been in the oil fields, he had used leaves as a substitute for toilet paper. He always had enjoyed excellent health until 1919. Since that time, when he had been traveling on the trains, he often had found it necessary to shift about in the seat because of discomfort, which he described as "a feeling as if he were sitting on a broken spring." In 1920, he first had felt a soreness in the region of the rectum when walking. At that time, a small lesion, which he thought was a boil, had been discovered 1½ inches (3.7 cm.) to the left of the anus. He had removed the head of this lesion, and a few drops of thick, yellow pus had escaped. During the following years, the lesion had healed; pus had been discharged intermittently, but nothing had been done therapeutically until 1929, when he had consulted his family physician because of a similar lesion which had appeared near the first one. The second lesion had opened spontaneously, and it had been found that the two sinuses were connected. A rubber drain had been drawn through the tract between the two sinuses; this had been allowed to remain for several days. After the drain had been removed, the sinus 1½ inches to the left of the anus had healed in a few days but within a week it had broken down again and thick, yellow pus had been discharged continuously. In 1933, an attempt had been made to excise the sinus tract, but healing had not occurred.

Physical examination at the clinic disclosed that the man was well preserved. The pulse and temperature were normal; there was no pallor and the lungs were clear. Roentgenographic examination did not disclose any abnormality. Proctoscopic examination disclosed an indurated and inflamed mass in the left buttock; the mass contained two sinuses. One was situated 6 cm. to the left of the posterior margin of the anus, and the other was situated 4 cm. to the left of the anterior margin. (Fig. 4.)

The value for hemoglobin was 13.7 Gm. per 100 c.c. of blood. A flocculation test for syphilis was negative. The patient was advised to undergo an operation but he decided to postpone treatment.

Fig. 4. Multiple, deep, anal fistulas associated with actinomycosis.

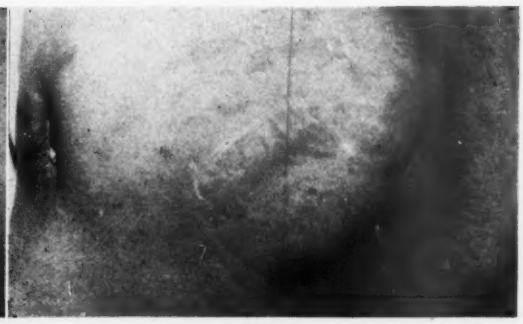

Fig. 5. Fistulas of left buttock in case of anorectal actinomycosis; photograph was taken shortly after a large abscess over the left hip had been incised and drained.

He consulted another physician elsewhere in November, 1933, and at that time an operation was performed and five sinus tracts were found to communicate with the two openings previously described in the skin of the buttock. At the operation "all tracts were scraped," but the wound failed to heal. Approximately three months after the operation, and while the wound was being dressed, a probe was believed to come in contact with a bone, which was thought to be the coccyx. Another operation was performed elsewhere in November, 1934, but the coccyx appeared to be normal and was not disturbed. All efforts to stimulate healing failed and pus continued to drain from the wound. Pain and soreness soon developed in the left hip. This pain increased when drainage from the sinuses diminished, and was relieved when good drainage was established. Up to this time, the man had lost 20 pounds (9 kg.); he had noted moderate loss of sphincteric control ever since the first operation in 1933.

In December, 1934, a roentgenographic examination of the bony structure of the pelvis, which had been made elsewhere, had been thought to disclose osteomyelitis of the sacrum.

He returned to the clinic on January 17, 1935. When he was examined at this time, the temperature and pulse were normal. Moderate pallor of the skin and mucous membranes was noted. Fistulas were found in the left buttock, and diffuse redness, swelling, and increased local temperature were observed over the left greater trochanter. There also were several deep, linear scars which extended from the anus to the left gluteal surface. The largest scar had several islands of granulation tissue at its base and there was another island of granulation tissue at the base of another sulcus. A communication with the rectum could not be demonstrated. Proctoscopic examination disclosed a large crypt in the median line of the anal canal, posteriorly, but no tract was found extending toward the external sinuses. The left posterior wall of the anus was distorted by scar tissue.

The hemoglobin was 11.9 Gm. per 100 c.c. of blood; the erythrocytes numbered 4,030,000 per cu. mm., and the urine was normal. Roentgenographic studies of the pelvis, left hip, and femur revealed evidence of some irregularity of the sacrum. There was considerable thickening of the soft tissue overlying the left greater trochanter.

The abscess of the left buttock (Fig. 5) was incised on January 21, 1935. It contained a large quantity of pus and exuberant granulation tissue. At that time, specimens of tissue and pus were taken from the abscess cavity. The pathologist reported that the tissue was inflammatory, but "sulfur granules" (Fig. 6) were found in the pus. The tissue of the left side of the sacrum was examined.

The treatment consisted of incision and drainage of the abscess. Potassium iodide was administered in doses of 25 gr. (1.6 Gm.) three times a day. Administration of larger doses was attempted, but without success, because of the patient's intolerance. Gauze packs saturated with compound solution of iodine (Lugol's solution) were applied within the walls of the abscess and fistulas. Deep Roentgen therapy was administered.

The patient finally left the clinic February 22, 1935. At this time the iodine packs and

potassium iodide were still being used. He was advised to continue the deep Roentgen therapy elsewhere.

Subsequent Course. When the patient was heard from on June 13, 1935, he complained of diarrhea and generalized abdominal cramps. This was interpreted as a reaction which might follow high voltage Roentgen therapy. One month and two days later, the sinus over the left hip remained the same as it had been. It was packed daily with a piece of gauze moistened in a compound solution of iodine (Lugol's solution). The probe was inserted approximately 3 inches. The sinuses about the anus were very sensitive to the insertion of the probe and to irrigations with hydrogen peroxide. There was a constant dull ache in this region and a mass was present. The patient complained of generalized weakness and an occasional sharp pain in the region of the sacrum. Medication consisted of the oral administration of 50 gr. (3.3. Gm.) of potassium iodide three times a day.

When the patient was heard from again on October 28, 1936, the sinuses had healed. The one over the hip had healed two months before this date and the large one near the anus had healed a short time after the first one had healed. The sacrum remained the same as it had been. The administration of iodide had been discontinued in January, 1936. In six weeks the sinuses had started to drain. The administration of iodide was started again and since February, 1936, all the sinuses were "nearly half closed" and in October, 1936, there was only slight drainage. The sacrum still remained unchanged. The attacks of sharp pain about the sacrum had disappeared.

The patient was heard from again on February 16, 1938. The iodide had been used constantly except for brief intermissions, at which time the drainage from the sinuses had become more profuse than it had been and discomfort had been noted over the left hip and about the anus. Several times after the sinus on the left apparently had healed pain around the region of the left hip had been noted; this had been accompanied by swelling. A small soft spot had appeared and had been drained. A large amount of pus had drained from this region and "sulfur granules" were found. This sinus tract had been completely healed for five months, but near the anus there was another sinus tract which discharged a small amount of thin pus intermittently. An applicator could be inserted 3 inches into this tract. This sinus, as well as the other, was treated by irrigations with hydrogen peroxide, by using a small tube and a syringe. The sinuses then were packed loosely with gauze soaked in compound solution of iodine

Fig. 6. Exudate obtained when an abscess was incised; "sulfur granules" are visible.

(Lugol's solution). Medication consisted of 60 gr. (4 Gm.) of potassium iodide three times daily; this dose was increased to 80 gr. (5.2 Gm.) three times a day at intervals until symptoms of iodism appeared. The patient said that "these large doses of potassium iodide always helped to dry up the fistulous condition." A recent examination of the blood revealed the erythrocytes and leucocytes to be normal in number. A cholecystectomy had been performed in 1936 because of chronic cholecystitis and cholelithiasis. At that time the patient had lost 20 pounds (9 kg.) but this weight had been regained and the patient weighed 189 pounds (85.7 kg.), his normal weight. His health was rather good and he was in Oklahoma attending to business regularly. Roentgenographic studies of the pelvis, which had been made in December, 1937 (Fig. 3) had revealed that the lower segments of the sacrum were more smooth and regular in contour than they had been.

SYMPTOMS

The symptoms of anorectal actinomycosis may be general, local, or both. There may be weakness, malaise, fever, loss of weight, abdominal pain, nausea, vomiting and diarrhea. These symptoms may be accompanied by such signs as the growth of a tumor about the anus or rectum, or by one or more abscesses with draining sinuses. In some cases, anemia is prominent only after the disease becomes chronic. Local symptoms may include only painful defecation and the formation of a tumor mass about the anus or in the rectum and single or multiple fistulas-in-ano. Melena is not usually seen, although the vascularity of this granulomatous process is always striking at operation. A small furuncle about the anus may be present for many years. This may discharge intermittently and be noticeable only because of soiling of the undergarments. This sign was noted in the present case and in the case reported by Nové-Josserand. Associated with this sign is the history of the possibility of direct contamination by the use of leaves for cleansing after defecation.

Four phases of anorectal actinomycosis were described by Bensaude in 1933. The initial phase consists of proctitis which is accompanied by fever, abdominal cramps and diarrhea or constipation. The second phase is one of woody infiltration; the third phase consists of the formation of abscesses and fistulas. The fourth phase consists of the complications. These may be of three types: (1) those which occur in situ, such as multiple deep fistulas, abscesses which may result in the formation of cavities, and stenosis of the anus or rectum; (2) those which occur by continuity, such as involvement of the pelvic viscera; and (3) those which occur at a distance, such as abscesses of the liver and septicemia.

DIAGNOSIS

The diagnosis of anorectal actinomycosis is based on the history of a chronic draining sinus or sinuses, physical and proctologic examinations, and the discovery of actinomycetes in the pus or tissues of the sinus or cavity. A specimen of the exudate (Fig. 6) is placed in a test tube with some water or physiologic solution of sodium chloride. The "granules" are isolated and placed on a glass slide in a drop of a 20 per cent solution of potassium hydroxide, crushed with a coverslip, and examined immediately with the low power objective of the microscope. If the antinomycetes are not found in this manner, specimens obtained by curettage or a section of the tissue obtained from the region of the abscess may be imbedded in paraffin and stained with Gram's stain or with hematoxylin and eosin. When these sections are cut and examined the organism and its characteristics may be observed.

DIFFERENTIAL DIAGNOSIS

Anorectal actinomycosis must be distinguished from such conditions as benign stricture, anal fistula, tuberculosis of the anorectal region, carcinoma, sarcoma, amebic dysentery, and lymphopathia venereum. The first five conditions may be distinguished from actinomycosis by the history or by examination of the exudate or a section of the tissue. If tuberculosis is

suspected and if the tubercle cannot be demonstrated and the microscopic picture is debatable, guinea pig inoculation must be resorted to. Amebic dysentery may be diagnosed by the history of moderate diarrhea, the passage of small amounts of blood in the stools; careful examination of a warm specimen of the stool may reveal Endamoeba histolytica.

PROGNOSIS

When actinomycosis is found in any part of the body, the prognosis should be very much guarded. In the anorectal region, the disease is equally as serious as it is in other parts of the body. In most of the cases reported in the foreign literature the patients either died in a short time or the outcome was not disclosed. In the reported cases the average duration of life after the patients consulted a physician was approximately one year. In the case reported by Perry the patient had lived fifteen months when he last was heard from. In the case reported in this paper the diagnosis of anorectal actinomycosis was made in January, 1935; when the patient was last seen in February, 1938, he was enjoying rather good health and was attending to business regularly. Death is usually the result of propagation of the mycotic process (Geissler), amyloid degeneration (Rotter), or septicemia which is caused by secondary infection (Poncet and Bartsch).

SECONDARY LESIONS

The perianal or perirectal tissues are usually involved, but as the disease progresses any structures about the pelvis may be vulnerable as the granulomatous process follows the line of least resistance. Fistulas may develop between the intestines and bladder or between the liver and intestines; the latter condition likely is the result of direct extension of an abscess of the liver that is secondary to the primary rectal lesion. There may be infiltration of the vesical and periprostatic cellular tissue. Occasionally, the Fallopian tubes, testes, ovaries and appendix may be secondarily invaded by a primary anorectal lesion.

TREATMENT

Treatment usually is not followed by very gratifying results except in those cases in which the disease is recognized early and therapeutic measures are instituted before the process has become very extensive. There are at present only three general therapeutic measures which may arrest the disease, namely, operation, the use of iodides, and the use of irradiation. Since the organism is anaerobic, Wangensteen said: "Complete and wide excision of the involved tissue when possible should be performed as soon as the diagnosis is made." There are cases in which excision is either unwise or impossible, especially if considerable exploring or manipulation is necessary; in such cases there is danger of spreading the organisms to other parts of the body. In such cases incision should be made, the sinus tracts should be curetted thoroughly, and ample drainage should be instituted. When toxic symptoms are present, such as malaise, fever, nausea, and vomiting, they may be relieved by the drainage of the abscess or by the formation of a sinus. Iodides have been used in all types of granulomatous conditions and some improvement has been noted. Iodide is not a specific remedy for actinomycosis, but when administered in large doses it seems to assist in arresting the symptoms. At the present time the patient in the case I observed is taking between 60 and 80 gr. (4 to 5.2 Gm.) of potassium iodide three times a day and has taken this dosage since 1935. The sinuses partially dried up until the symptoms of iodism appeared but when he discontinued the iodides the sinuses reappeared. The sinuses were irrigated with hydrogen peroxide and then packed lightly with gauze saturated with compound solution of iodine (Lugol's solution). The skin around the sinuses must be carefully protected with vaseline gauze when the packs saturated with compound solution of iodine are used. This method of

treatment is usually carried out twice a day.

In addition to surgical measures and the oral administration of large doses of iodides, radiotherapy has been found useful. In cases of anorectal actinomycosis Desjardins advises treatment with high voltage Roentgen therapy. He uses from 400 to 500 Roentgens generated at a potential between 140 and 200 kilovolts and filtered through 6 mm. of aluminum or 0.75 mm. of copper depending upon the size of the patient. The number of pelvic fields should be between 4 and 6, and in addition one perineal field should be treated. The maximal improvement requires that the treatment should be repeated several times and that the dose and the scheme of irradiation should be varied. Kleesattel and Ingber have both indicated that Roentgen rays or radium has no effect upon the organism. Iser wrote: "The effects of *x*-ray treatment in actinomycosis are not explained by the action on the fungus, but on its habitat." One of these methods of treatment, when used alone, has not proved successful, but when all three are combined the results are better. Vaccines have not proved successful in the treatment of this disease.

SUMMARY

Anorectal actinomycosis is rare. The portal of entry of the actinomycetes is unknown although direct contamination of any anorectal wound by cleansing with leaves or grass may offer a direct contact for the actinomycetes. The lesions in bone are uncommon; they may be the result of the secondary infection that accompanies actinomycosis rather than the result of primary involvement of bone by the fungus. Seventeen cases of anorectal actinomycosis have been reported previously. The case reported in this paper brings the total number of cases in the literature to eighteen. The diagnosis depends upon the finding of the "sulfur granules" in the exudate obtained from one of the sinuses, or on the microscopic examination of a specimen of tissue which has been stained with hematoxylin and eosin or with Gram's stain. There is no specific treatment for anorectal actinomycosis. Surgical drainage of the abscess with a minimal amount of manipulation, sufficient doses of potassium iodide, and a satisfactory regime of high voltage Roentgen therapy have proved satisfactory in allaying the symptoms in some cases.

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FRACTURE OF THE JAWS*

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THE increasing incidence of fracture of the maxillary and mandibular bones may be ascribed to the accidents resulting from the more frequent use of the automobile. When more evident injuries involve other parts of the body there is a tendency to neglect examination of the facial bones. Moreover, every community does not have someone suitably trained to handle this type of bone injury. As a consequence of delayed or inadequate treatment, there is the possibility of permanent deformity. We should like to call attention to certain fundamentals in management, to describe simplified methods of fixation and to point out effective means of controlling complications. Such requisites are essential if good functional and cosmetic results are to be obtained.

DIAGNOSIS

Fracture may be caused by violence of a direct or indirect nature. The sudden impact of a great force against the face, as in striking the steering wheel, the removal of neoplasms of the jaw and the removal of deeply imbedded teeth may be etiologic factors in producing injury. Osteomyelitis may be a predisposing cause of spontaneous fracture.

The diagnosis depends upon careful clinical examination which should be supplemented by an *x*-ray survey. There is the usual history of injury. The symptoms, broadly speaking, are similar to those accompanying fracture of the other bones of the body. There is local tenderness, swelling, ecchymosis, mobility of the parts and impairment of function. Traumatization of the branches of the fifth nerve frequently leaves a state of anesthesia of the areas innervated. This is especially true of the lower lip in cases of fracture of the mandible. When teeth are present in both jaws, a commonly observed and most dependable sign is malocclusion.

The roentgenogram furnishes a valuable and convenient means of determining the location and type of fracture. However, there are certain regions of the jaws which are difficult to *x*-ray accurately. Either because of the inability to obtain the proper focus or to superimposition of the shadows of contiguous bones, there may result negative roentgenographic evidence. This is particularly true in fractures of the upper jaw and the neck of the condyle. The maxilla does not lend itself to such clear exposures as the opposing jaw. There is a tendency of the cranial bones to obscure and blur maxillary fractures. As a consequence, clinical evidence in diagnosing fractures of the maxilla is much more reliable. The routine practice of making two lateral jaw exposures of the lower jaw cannot be considered a complete survey. Too frequently, fractures at the midline and neck of the condyle are overlooked. Good details of the latter may be obtained by employing the same technique as used in views of the mastoid area.

FRACTURES OF THE MAXILLA

Fractures of the maxilla are more likely to be comminuted than those of the mandible; therefore, facial asymmetry is more prone to follow. The presence of such associated injuries as crushed walls of the sinuses and fractured malar and nasal bones, demands that the treatment be a carefully planned and meticulous procedure. The injury may be as simple as involvement of part of the alveolar process or so extensive as to sever the maxillae from their attachment to the skull. The line of cleavage in transverse fractures may

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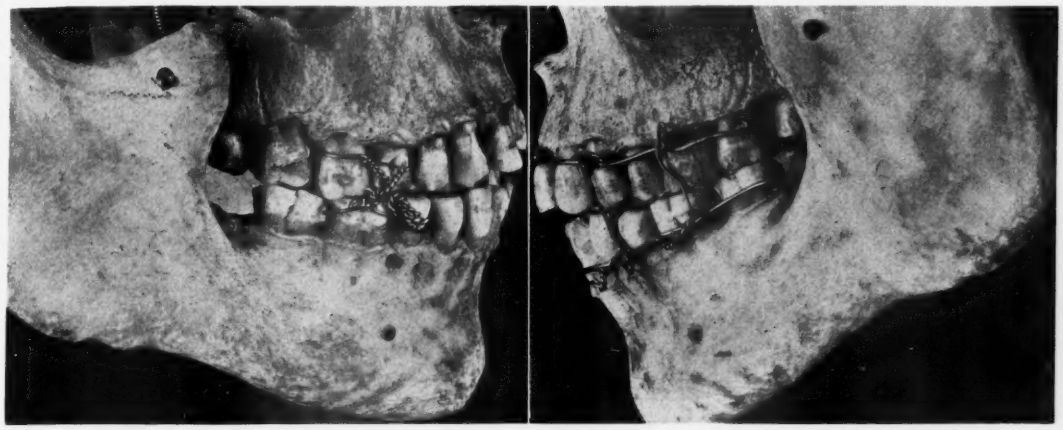
be through the antra or higher up through the orbital cavities. In both cases there is the tendency for the face to elongate, the whole of the dental arch being movable and held only by the soft tissues. Occlusion of the teeth is usually limited to the posterior parts of the jaws.



A B

Fig. 1. A, Gilmer No. 1 method. Single wires twisted about adjoining teeth, crisscrossed and wound about wires similarly placed on occluding teeth. B, Gilmer No. 2 method. Heavy metal arch ligated by small wires to labial aspect of maxillary teeth.

The treatment of fractures of the maxilla, except the transverse type, may be instituted by the various methods which will be dealt with in detail later. Complete fractures are best handled by exerting upward pressure on the jaw, utilizing the top of the head as a point of fulcrum. A dental splint is constructed and placed snugly about the teeth of the upper jaw which is carried gently to its former anatomic place by means of elastic traction. The exact position is gauged by establishing the previous occlusion of the teeth.

THE MANDIBLE

The lower jaw is more exposed to violence and is more often fractured than any other of the facial bones.[1] Fracture of the mandible may occur at any point from the symphysis to the glenoid cavity. Most often the body of the bone is involved especially at or near the angle. The second most frequently fractured site is in the region of the mental foramen. Double fractures commonly include both these regions. Fracture of the ramus and its processes is not so rare as is believed. Injury to the neck of the condyle is often associated with fracture at the midline. Fractures of the body of the mandible are compound and therefore communicate with the mouth through the oral mucosa; those of the ramus are of the closed type. Injury to an edentulous mandible may be followed by extreme displacement of the fragments; because of the absence of teeth compounding of the fracture seldom results.

When consideration is given to the anatomic structure of the mandible, to the innumerable muscles to which it furnishes attachment, and to the opposing directions of pull, it is not surprising that fracture should so often be characterized by marked displacement. The treatment is dependent upon a knowledge of the musculature and of the various mechanical devices for fixation.

In a normally functioning jaw the muscles are in a fine state of balance. However, a break in the continuity of the bone upsets this equality of balance, producing traction of a greater degree in one direction than in another. Displacement is the obvious consequence. In a general way, unless prevented by the direction of the fracture line, upward pull is the result of the combined forces of the masseter,

temporal and internal pterygoid muscles; downward displacement is occasioned by the mylohyoid, digastric, geniohyoid and

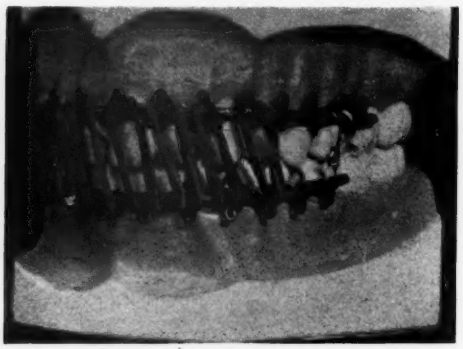


Fig. 2. The principle of elastic traction. Small elastics extended from maxillary to mandibular teeth, exerting constant pull.

genioglossus muscles. To overcome this condition of unbalanced action and to restore the parts to a state of equilibrium is a problem in dental mechanics.

TREATMENT

Treatment should accomplish two results: (1) bony union and (2) restoration of normal occlusion of the teeth. The achievement of the first objective without the other, will result in interference with the proper function of the mandible. It is for this reason that the reëstablishment of the former relationship of the teeth assumes major importance. Moreover, normal occlusion is an ideal guide to correct reduction.

No two individuals possess exactly the same bite. There are, however, certain general conditions found in most mouths. The anterior teeth of the upper jaw usually overlap their antagonists of the mandible; the biting surfaces of the maxillary posterior teeth strike those of the lower jaw in such a manner as to incline slightly backward and to the side. A clue to the establishment of correct occlusion is furnished by noting the cusps which exhibit smooth surfaces as a result of wear. The articulation of these surfaces must closely approximate normal for the particular patient.

Various devices and procedures have been employed to effect reduction and fixation of fractured jaws. A brief discussion of each with an evaluation from a practical standpoint may be of interest.

Bandages. The Barton and other forms of head bandages are of little value as a permanent means of immobilization. In many cases their use is distinctly contraindicated. In simple fractures without disturbance of occlusion, the application of a bandage helps to afford a sense of security. Good results thus obtained may be attributed as much to the psychological effect on the patient as to the utilitarian value of the bandage. Today more cases are being seen which are characterized by comminution and extensive displacement. The use of a bandage in such cases not only fails to accomplish the desired results, but in reality tends to increase displacement. Should swelling of the soft tissues occur under a bandage, the pain and discomfort become intolerable. When used as a supplement to other forms of fixation, the bandage can be said to have reached the limit of its practical usefulness.

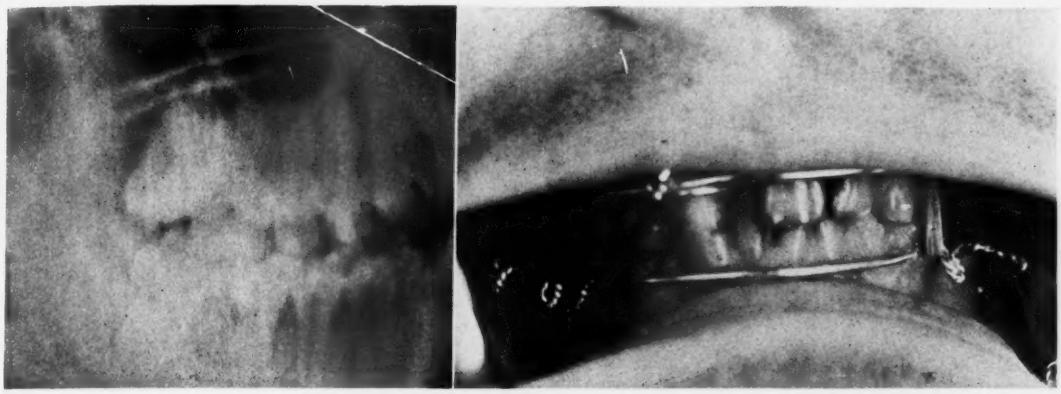
Splints. The use of splints for the purpose of reduction, except in special cases, is now considered unnecessary. The construction of metal and vulcanite splints is a time-consuming procedure which causes unnatural delay in instituting treatment.

Metal Plates. The placing of a piece of metal, such as the Lane plate, across the fracture line and attaching it by means of screws is now looked upon as an ill-advised and antiquated operation. Clinical experience has shown that frequently osteomyelitis develops.

Direct Wiring. The coaptation of the fractured parts by wiring one to the other is restricted to certain cases. It is indicated in fractures of edentulous jaws which do not lend themselves to other effective means of treatment. The facility of the intraoral approach and the fine results obtained have been recently emphasized.[2]

Intraoral Ligation. The simplest, the most universally employed and the most

satisfactory method of immobilization is obtained by the use of interdental wiring. Applicable in the vast majority of cases, it possesses many advantages over other methods. It is a non-surgical procedure; occlusion of the teeth is always visible; it possesses none of the cumbersome characteristics of splints; opening the mouth for inspection does not materially disturb the relationship of the bone; and finally, it is neither irritating nor unhygienic.



A B

Fig. 3. A, *x*-ray showing fracture of condyle of mandible with displacement. Malocclusion of teeth very pronounced. B, same case after reduction. Immobilized by Gilmer No. 2 method plus elastic traction.

Practically all types of wiring used in the present day treatment of jaw fractures are founded on the basic methods developed by the late Dr. Thomas L. Gilmer of Chicago.[3] Recognizing the fact that bringing the upper and lower jaws into occlusion was a practical way of not only properly approximating the parts, but of satisfying all the fundamental requirements essential to correct reduction, he devised two wiring methods which have become known as Methods No. 1 and No. 2.

The first method consists of twisting separate strands of 22-gauge brass wire about the necks of the adjoining teeth, crisscrossing the wires and winding them to wires similarly attached to the occluding teeth. When applied to the bicuspid and molar teeth of each side in addition to the anteriors, the result is that the two jaws can be closed in proper position.

The second method is indicated when several teeth are missing. A 14-gauge arch wire is fashioned to the labial aspect of each dental arch and held in place by fine wires which are ligated about several teeth. The jaws are brought into occlusion by intermaxillary tie wires which join the upper and lower metal arches. Thus the basic principle of establishment of the normal occlusion is carried out.

These two methods may be used over a wide range. However, many modifications of each have been made. The Ivy eyelet method is a very satisfactory device. It possesses advantages of both Gilmer methods.

The excellent results obtained in reduction by utilizing elastic traction prompts us to call attention to a phase of treatment, which, though far from being novel, is sometimes overlooked. In badly displaced cases reduction becomes a procedure of constantly tightening the intermaxillary wires until the process is completed. It is, to say the least, unpleasant from the patient's viewpoint. However, when small elastics are attached to the upper and lower wire hooks or projections, gradual and painless reduction immediately starts and often is completed within a few hours' time. It is particularly effective in late treated cases in which fibrous union has taken place. Permanent fixation is easily obtained by later substituting fine wires for the elastics.

There are certain types of fractures of the mandible which, because of problems in management, deserve special mention. Fractures occurring at the angle leave an

edentulous posterior fragment which exhibits a tendency to "ride up" and eliminate the usual space between both jaws. Union in these cases can only be obtained by using some mechanical means to place the elevated part back in contact with the larger fragment. A vulcanite splint fitted over the alveolar ridge of the fractured area usually is an effective solution of the problem. Fracture of an edentulous mandible is best treated by utilizing the patient's artificial dentures; reduction is completed by using an external elastic bandage. In badly displaced cases direct wiring or the circumferential method of Black are indicated.[4]

A B

FIG. 4. A, *x*-ray showing fracture at angle of the lower jaw with ramus elevated. B, same case after reduction.

The management of fracture of the neck of the condyle has occasioned a great deal of comment and discussion. When displacement of the head of the process occurs there is a deviation of the midline to the side of the injury. Operations have been suggested to remove the condylar head because of fear of ankylosis. Such procedures present hazards and difficulties. It is worthy to note that in most cases clinical results obtained by wiring the upper and lower teeth in occlusion and disregarding the displaced condyle, have been most satisfactory.[5] The temperomandibular joint possesses the faculty of adjusting itself to the new condition. Therefore, the conservative treatment as here outlined is advocated.

COMPLICATIONS

The early complications such as hemorrhage and respiratory embarrassment usually disappear after reduction has been carried out. Late complications are cellulitis, osteomyelitis, malunion and nonunion. When swelling progresses to the stage of suppuration, incision of the soft tissues, providing an adequate vent for the pus, may prevent infection of the bone. Prolonged suppuration is indicative of osteomyelitis. This condition demands that ample drainage be established and maintained and sequestra be removed when separated from live bone. In a case complicated by infection of the bone osteogenesis is slower. Delayed union may result from failure to immobilize early, incorrect approximation of the fragments, the interposition of fibrous tissue and such general diseases as syphilis, tuberculosis and diabetes. Malunion invariably may be traced to improper reduction. Nonunion is comparatively rare. Restoration of the continuity of the jaw can only be obtained by resorting to bone grafting.

SUMMARY

1. More frequent use of the automobile has tended to increase the incidence of fracture of the maxilla and mandible.

2. Diagnosis depends on both clinical and *x*-ray examination.

3. Treatment should be directed toward obtaining bony union and restoring the normal occlusion of the teeth.

4. The maintenance of ample drainage and removal of sequestrated bone are fundamental to the control of complications.

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Intubation is the process by which a hard-rubber tube is introduced into an edematous and occluded larynx through the glottis. It is generally done in cases of laryngeal diphtheria in which the larynx has become so swollen as to threaten asphyxiation.

DIAPHRAGMATIC HERNIA IN CHILDREN*†

A RÉSUMÉ OF SIXTY-EIGHT CASES OCCURRING IN CHILDREN UNDER TEN YEARS OF AGE TREATED BY OPERATION

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THE surgical repair of diaphragmatic hernias in infants and young children is still a relatively uncommon surgical procedure. With the advances made in roentgenology during the past fifteen years, many more diaphragmatic hernias are diagnosed during life than formerly, and with the progress made in the technique of anesthesia and thoracic surgery, a great many more cases have been successfully operated upon.

Hedblom[1] has written a most comprehensive discussion covering the whole subject of diaphragmatic hernia, and has collected 2,137[2] cases, including 629 cases of the esophageal hiatus type. Rankin and Grimes[3] have written a brief but excellent review, discussing in considerable detail the history of the development of the operation itself. Harrington[4] has reported 120 cases of various types upon which he has operated. Over 700 articles touching various phases of this subject have appeared in the literature during the past ten years.

Only an occasional author, however, reports an operation on a patient under ten years of age. A recent report by Truesdale[5] lists fifty such cases. Orr and Neff[6] have collected seventeen congenital cases under one year of age. Lissowetzky,[7] in the course of 220 routine autopsies on infants, found three congenital diaphragmatic hernias. In each case it had been the cause of death. He believes that, could an early diagnosis be made and surgical repair resorted to, the lives of many such cases might be saved. Greenwald and Steiner[8] collected eighty-two cases of diaphragmatic hernias in infants and young children reported from 1912 to 1929. Only eleven, however, were operated upon, and only six of these survived. They also stress the importance of an early diagnosis. In the newborn infant the prognosis is poor, death being due chiefly to cardiac and pulmonary interference, as shown by the attending cyanosis and dyspnea. In older children the prognosis is better. Here intestinal obstruction and strangulation is the most common cause of death. In their series of eighty-two cases, forty-six were diagnosed at autopsy. Most of these were young infants. It is probable that, had they been diagnosed early and repaired, some of these would have survived. Woolsey[9] reported 106 cases collected from the literature. Thirty-six of these were in infants and children under ten years of age, in which diagnosis was not made until the autopsy was performed. He feels that in 71 per cent of his entire group of fatal cases, had an early diagnosis been made and operation performed, death might have been averted.

Diaphragmatic hernias are considered to be true or false, depending upon the presence or absence of a sac. Harrington[4] has classified them as follows: "a nontraumatic diaphragmatic hernia may be congenital or acquired.

"1. If congenital, the hernia is attributable to embryologic deficiency, and usually is without an enclosing sac. The most

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common sites in the probable order of frequency of occurrence are: (1) through the hiatus pleuroperitonalis (foramen of Bochdalek); (2) through the dome of the diaphragm; (3) through the esophageal hiatus; (4) through the foramen of Morgagni; (5) through the gap left by the partial absence of the hemidiaphragm which is usually in the posterior portion of the muscle.

"2. If acquired after birth, the sites of occurrence are: (1) through the esophageal hiatus—this type has an enclosing sac; (2) through the region of fusion of the anlage of the diaphragm; (3) at sites named under congenital types.

"3. Traumatic diaphragmatic hernia may be caused by direct or indirect injury, or by inflammatory necrosis of the diaphragm. (1) In indirect injury to the diaphragm, the hernia may occur at any point, including points of embryologic fusion, but the most common region is the dome and posterior half of the left hemidiaphragm—it may occur in the right hemidiaphragm. It is usually the result of a severe, crushing injury and the hernia may or may not have a hernial sac. When the hernia is through the esophageal opening there is a sac, but when through the leaf of the diaphragm, there is usually no sac. (2) In direct injury to the diaphragm, the hernia may occur at any point, and is usually the result of penetrating wounds, such as those inflicted by a gunshot or a knife. (3) Rupture of the diaphragm may be the result of inflammatory necrosis, which in turn has been caused by a subdiaphragmatic abscess or rupture may follow necrosis from drainage tubes introduced into empyema cavities. In these cases the opening in the diaphragm is usually posterior and there is no hernial sac."

We have reviewed sixty-eight cases of diaphragmatic hernia occurring in infants and children ten years of age or under which have been treated by operation. (Table 1.)

In this series of sixty-eight operated cases ten years of age or younger there were twenty-two deaths a total mortality

Fig. 1. *X*-ray twenty-four hours after injury, showing air-containing viscera in left thorax and absence of left diaphragm shadow.

of 32 per cent. Nineteen patients died shortly after operation, that is, before leaving the hospital, and are classed as operative deaths. Three died after leaving the hospital, one two months later, and the second six months later of recurrence which resulted in obstruction. In neither was a second operation done. In the third case the hernia recurred in six months, and the patient died after a second operation for repair. These three cases are classed as deaths in this tabulation. There were two more recurrences, making a total of five (7.4 per cent). These two patients were operated on again. One made a satisfactory recovery and has remained well. In the other case the hernia recurred twice more and following the third operation has remained well. Twelve cases showed definite signs of obstruction on admission. Eight of these died. There were fourteen cases in which the hernia was definitely attributable to a traumatic injury, and although these are acquired cases, they are differentiated in this paper by listing them separately as traumatic cases. There are only four non-traumatic cases which we

can be certain were definitely acquired. In three of these cases the hernia appeared following an empyema, in the fourth it appeared while the patient was convalescing from influenza. We have listed as congenital, all non-traumatic hernias where we cannot be quite certain that they were acquired.

TABLE I.

RESUME OF 68 CASES OF DIAPHRAGMATIC HERNIA IN CHILDREN UNDER 10 YEARS OF AGE TREATED BY OPERATION.

NO.	YEAR	REPORTED BY	AGE SEX	ETIOLOGY	DOMINANT SYMPTOM	HOW DIAGNOSED	APPROACH	CONTENTS	LOCATION	ANESTHESIA	RESULT	REMARKS
1	1889	O'DWYER[6] U.S.A.	3 YR. ?	CONGENITAL	DYSPNEA OBSTRUCTION FEVER 105	BY OPERATION	THORACIC	STRANGULATED INTESTINE AND COLON	LEFT	NOT RECORDED	DIED	DIAGNOSED EMPYEMA PUS PRESENT
2	1896	MAYLARD[11] SCOTLAND	8 YR. M.	CONGENITAL	VOMITING PAIN IN L.F. HYPOCHONDRIUM ABDOMINAL DISTENTION	BY OPERATION	ABDOMINAL	STRANGULATED COLON AND OMENTUM	LEFT	NOT RECORDED	DIED	COLON RETURNED TO ABDOMEN DIAPHRAGM NOT REPAIRED
3	1902	AUE[12] GERMANY	9 YR. M.	ACQUIRED APPEARED 1 YR. AFTER EMPYEMA	VOMITING PAIN IN LEFT SHOULDER	PHYSICAL FINDINGS	ABDOMINAL	PART OF STOMACH	LEFT MEDIAL	NOT RECORDED	LIVED	WELL 10 YRS. AFTER
4	1917	MC CLEAVE[13] U.S.A.	3½ MO. M.	CONGENITAL	PAIN RELIEVED BY VOMITING DYSPNEA CYANOSIS	X-RAY	ABDOMINAL	INTESTINES	LEFT POST.	NOT RECORDED	DIED	OPERATED BY DR. L. P. ADAMS
5	1918	DOWNES[14] U.S.A.	7 YR. M.	CONGENITAL	VOMITING FAILURE TO GAIN WEIGHT	X-RAY	ABDOMINAL	STOMACH PART OF DUODENUM	LF. ESOPH. HIATUS	INTRATRACHEAL	LIVED	STOMACH COULD NOT BE WITHDRAWN FROM THORAX POST. GASTRO JEJUNOSTOMY
6	1919	DE BUYS[15] U.S.A.	3 MO. F.	CONGENITAL	DYSPHEA OBSTRUCTION COLIC UNABLE TO SWALLOW OR VOMIT	BY OPERATION	ABDOMINAL	STOMACH COLON OMENTUM	LEFT POST.	ETHER	DIED	
7	1920	GREIWE[16] U.S.A.	5 YR. F.	CONGENITAL	VOMITING CONSTIPATION COUGHING	X-RAY	ABDOMINAL	STOMACH	LF. ESOPH. HIATUS	NOT RECORDED	LIVED	WOUND DISRUPTION 7TH P.O. DAY - RECOVERED AUTHOR THINKS NOT ACQUIRED
8	1920	SPEIR[17] U.S.A.	5 YR. M.	CONGENITAL	SYMPTOMS OF PYLORIC ULCER, PARTIAL INTESTINAL OBSTRUCTION	BY OPERATION	ABDOMINAL	STOMACH	LEFT	NOT RECORDED	LIVED	
9	1920	AUE[12] GERMANY	5 YR. M.	CONGENITAL	VOMITING NAUSEA AFTER MEALS WEIGHT 14 LB.	X-RAY	ABDOMINAL	STOMACH COLON APPENDIX	RIGHT ESOPH. HIATUS	ETHER	DIED	OPERATED BY PROF. HEDENHAIN - RECURRED DIED 2 MO. POST OP.
10	1921	TRUESDALE[18] U.S.A.	5 YR. M	TRAUMATIC RUN OVER BY AUTO	NAUSEA CHOKING SPELLS DYSPNEA	AUSCULTATION X-RAY	THORACIC	MOST OF G.I. TRACT SPLEEN LF. LOBE LIVER	LF. PARA ESOPH. HIATUS	POSITIVE PRESSURE GAS O. ETHER	LIVED.	RECURRED 3 TIMES REOPERATED LIVED
11	1921	TRUESDALE[19] U.S.A.	3½ YR. M.	TRAUMATIC RUN OVER BY AUTO	SHOCK	X-RAY	ABDOMINAL	STOMACH JEJUNUM TRANS. COLON LF. LOBE OF LIVER	LF. DOME SMALL TEAR IN RT.	POSITIVE PRESSURE	LIVED	OPERATED BY O'CONNELL
12	1921	GOETSCH[20] U.S.A.	8 YR. F.	TRAUMATIC STRUCK BY AUTO	NAUSEA DYSPNEA PAIN	X-RAY	THORACIC	STOMACH COLON	LF. DOME	ETHER OXYGEN INTRATRACHEAL	LIVED	ALSO REPORTED BY GORDON AND GOLANN[21] PERSONAL COMMUNICATION
13	1921	BARNETT[22] ENGLAND	8 MO ?	CONGENITAL	VOMITING CYANOSIS OBSTRUCTION ABD. DISTENTION	BY OPERATION	ABDOMINAL	STOMACH TRANS. COLON INTESTINE SPLEEN	LF. DOME ABSENT	NOT RECORDED	DIED	OPENING COULD NOT BE CLOSED
14	1922	LEPOUTRE[23] FRANCE	3 MO F.	CONGENITAL	DYSPHEA CYANOSIS AFTER FEEDING UNDER WEIGHT	X-RAY	COMBINED	STOMACH ILIUM COLON	LEFT	NOT RECORDED	DIED	ARTIFICIAL RESP. MASSAGE OF HEART DURING OPERATION
15	1924	BEHREND[24] U.S.A.	8 YR. M.	ACQUIRED EMPYEMA 5 MO. BEFORE	VOMITING PAIN CONSTIPATION	X-RAY	ABDOMINAL	STOMACH TRANS. COLON OMENTUM	LEFT CENTRAL	LOCAL	LIVED	OBSTRUCTED 1 MO. P.O. REOPERATED LIVED
16	1924	CARMAN[25] U.S.A.	5 YR. F.	TRAUMATIC RUN OVER	ATTACKS ABD. PAIN DISTENSION BELCHING WORSE WITH EXERTION	X-RAY	THORACIC	SMALL INTESTINE OMENTUM SPLEEN	LEFT CENTRAL 12 CM LONG	POSITIVE PRESSURE NITROUS OXIDE O.	DIED	BECAME CYANOTIC DIED IN SHOCK OPERATED BY DR. C. A. HEDBLOM

The incidence is higher in males than in females, and the mortality slightly lower. Hedblom[1] found in 197 cases of all ages, that 78.6 per cent were males, and 24.4 per cent females. Greenwald and Steiner[8] found 68.9 per cent males and 31.1 per cent females in their series. In forty-one cases the sex was not recorded.

Many other symptoms and physical findings besides those listed in Table III occurred, such as: malnutrition, anemia, choking spells, difficulty in nursing or swallowing, emptiness of abdomen, refusal of feedings, belching, diarrhea. Many of these could probably be included under the more frequently listed terms. It will be seen from this tabulation that under 1 year of age, cyanosis, dyspnea, and vomiting are the most common findings, while over one year, vomiting, pain and colic are the most common complaints. This agrees with the findings of Greenwald and Steiner.[8] Under one year the dominant symptoms are the result of cardiac and pulmonary

17	1924	CARMAN[25] U.S.A.	9 YR. M.	CONGENITAL	LEFT ABDOMINAL CRAMPS FOR 1 YEAR	X-RAY	ABDOMINAL	MOST OF G.I TRACT SPLEEN	LEFT CENTRAL	ETHER	DIED	OPERATED BY DR. STARR JUDD
18	1925	SHERWOOD[26] U.S.A.	8 YR. M.	TRAUMATIC HIT BY TRUCK	TENDERNESS RIGIDITY UPPER ABD. - SHOCK	X-RAY	ABDOMINAL	STOMACH OMENTUM LF. LOBE OF LIVER	LEFT CENTRAL	NITROUS OXIDE ETHER	LIVED	FRACTURE OF THE 7TH, 8TH, 9TH AND 10TH RIBS
19	1926	TRUESDALE[8] U.S.A.	6 YR. F.	TRAUMATIC COASTING	INTESTINAL OBSTRUCTION	EXPLOR. LAPAROTOMY	COMBINED	TRANS. COLON OMENTUM	LEFT FORAMEN BOCHDALEK	POSITIVE PRESSURE GAS O_2 ETHER	LIVED	THREE FAILURES AFTER LAPAROTOMY
20	1927	WOOLSEY[9] U.S.A.	35DA. F	CONGENITAL	DYSPNEA CYANOSIS	X-RAY	ABDOMINAL	SMALL INTESTINE COLON APPENDIX OMENTUM	LEFT POSTERIOR	NOT RECORDED	LIVED	DIED OF VOMITING 1 YEAR LATER HERNIA O.K.
21	1927	JOWERS[27] ENGLAND	7 YR. M.	ACQUIRED	VOMITING PAIN	PRELIMINARY EXPLOR. LAPAROTOMY	ABDOMINAL	ALL SMALL INTESTINE MOST OF COLON	LF. DIAPH. DETACHED AT BORDER	INTRATRACHEAL	LIVED	FIRST SYMPTOM OCCURRED WHEN PT. WAS CONVALESCING FROM INFLUENZA
22	1927	SCHACKELTON[28] U.S.A.	9 YR. M.	TRAUMATIC OCCURRED WHILE WRESTLING	SUDDEN SEVERE UPPER ABD. PAIN DYSPNEA SHOCK	X-RAY	THORACIC	STOMACH COLON SPLEEN OMENTUM	LEFT POSTERIOR	NITROUS OXIDE O_2	LIVED	NOT POSITIVE PRESSURE ANESTHESIA PERSONAL COMMUNICATION
23	1927	STEPHENS[29] AUSTRALIA	8 WK. F	CONGENITAL	VOMITING DYSPNEA CYANOSIS	X-RAY	THORACIC	MOST SMALL INTESTINE CECUM APPENDIX	LEFT POST.	INTRATRACHEAL ETHER	DIED	DIED 6 MO LATER FROM OBSTRUCTION FROM 2ND DIAPHRAGMATIC HERNIA
24	1927	STEPHENS[29] AUSTRALIA	3 MO. M.	CONGENITAL	CYANOSIS CONVULSIONS "WINDY ATTACKS"	X-RAY	THORACIC	PART STOMACH, MOST SMALL INTESTINE, COLON CECUM AND APPENDIX	LEFT VENTRO LATERAL	INTRATRACHEAL ETHER	LIVED	
25	1927	CLARK[30] U.S.A.	3½YR. F.	CONGENITAL	VOMITING - ABDOMINAL PAIN - SENSE OF FULLNESS IN STOMACH	X-RAY	THORACIC	STOMACH PART OF SMALL INTESTINE COLON AND SPLEEN	LEFT ANTERIOR OF DOME	NOT RECORDED	DIED	PARA GASTRIC ABSCESS BROKE AT OPERATION
26	1927	TOREK[31] U.S.A.	4 YR. M.	CONGENITAL	NAUSEA CONSTIPATION ABDOMINAL CRAMPS AFTER EATING	X-RAY	ABDOMINAL	MOST OF STOMACH SMALL INTESTINE AND COLON	ESOPH. HIATUS LF. NO SAC	GAS O, ETHER	DIED	ALSO REPORTED BY LEOPOLD[32]
27	1928	TRUESDALE[10] U.S.A.	5 YR. F.	TRAUMATIC HIT BY AUTO	CYANOSIS - COUGH	X-RAY	THORACIC	STOMACH SMALL INTESTINE COLON SPLEEN	LEFT PARA ESOPH.	POSITIVE PRESSURE GAS O_2 ETHER	LIVED	
28	1928	PAUCHET, LUQUET[33] FRANCE	3 YR. F.	CONGENITAL	VOMITING PAIN CONSTIPATION	X-RAY	ABDOMINAL	STOMACH PART OF COLON	LEFT ESOPH HIATUS	NOT RECORDED	LIVED	
29	1928	OLMSTEAD[34] U.S.A.	6 MO. F	CONGENITAL	DYSPNEA CYANOSIS LOSS OF WEIGHT	X-RAY	ABDOMINAL	INTESTINES SPLEEN	LEFT CENTRAL	ETHER	DIED	THORACENTESIS BEFORE DIAGNOSIS
30	1928	MEYER[35] U.S.A.	FEW WKS. M.	CONGENITAL	VOMITING, SYMPTOMS OF INTESTINAL OBSTRUCTION	X-RAY	ABDOMINAL	PART OF SMALL INTESTINE AND COLON	LEFT	NOT RECORDED	DIED	ASPIRATED VOMITUS DIED ON TABLE
31	1929	BETTMAN[36] AND HESS U.S.A.	3½MO. F.	CONGENITAL	DYSPNEA CYANOSIS PAIN REFUSED FOOD	PERCUSSION AUSCULTATION X-RAY	COMBINED	INTESTINES COLON	LEFT LATERAL	POSITIVE PRESSURE ETHYLENE CO_2 O_2	LIVED	
32	1929	MCFADDEN[37] IRELAND	4 YR. F.	CONGENITAL	VOMITING PAIN CONSTIPATION	X-RAY	THORACIC	INTESTINES COLON, SPLEEN OMENTUM	LEFT ANTERIOR	NOT RECORDED	LIVED	
33	1929	BROWN[38] U.S.A.	5 YR. F.	CONGENITAL	COLICKY PAIN	X-RAY	ABDOMINAL	STOMACH INTESTINE SPLEEN	LF. ESOPH. TO LAT. CHEST WALL	NITROUS OXIDE O_2 ETHER	DIED	
34	1930	SANDERS[39] U.S.A.	5½YR. F.	ACQUIRED EMPYEMA 3YRS. BEFORE	ABD. PAIN NAUSEA VOMITING	X-RAY	COMBINED	PART OF STOMACH TRANS. COLON ENTIRE OMENTUM	LEFT POST.	POSITIVE PRESSURE ETHYLENE	LIVED	

embarrassment, while over one year, they are the result of a partial obstruction of the gastrointestinal tract.

TABLE I (CONTINUED)

NO	YEAR	REPORTED BY	AGE SEX	ETIOLOGY	DOMINANT SYMPTOM	HOW DIAGNOSED	APPROACH	CONTENTS	LOCATION	ANESTHESIA	RESULT	REMARK
36	1930	TRUEDALE[18] U.S.A.	1YR. F.	CONGENITAL	REFUSED FEEDING DIGESTIVE UPSET CRYING SPELLS	X-RAY	THORACIC	STOMACH SPLEEN	LF. ESOPH. HIATUS NO SAC	POSITIVE PRESSURE GAS O_2 ETHER	LIVED	
36	1930	TRUEDALE[18] U.S.A.	17 MO. F.	CONGENITAL	ABDOMINAL PAIN OBSTRUCTION DISTENSION COUGH	X-RAY	THORACIC	STOMACH COLON SMALL INTESTINES	LEFT FORAMEN BOCHDALEK	POSITIVE PRESSURE GAS O_2 ETHER	LIVED	CECOSTOMY 1 WK. BEFORE
37	1930	SCHOMBAUER WARKANY[43] GERMANY	3 MO. ?	CONGENITAL	VOMITING DYSPNEA COUGH LOSS OF WEIGHT	X-RAY	COMBINED	PART OF STOMACH ALL SMALL INTESTINE MOST COLON, SPLEEN	LEFT DOME	ETHER	LIVED	
38	1930	HARRINGTON[41] U.S.A.	7MO. F.	CONGENITAL	SEVERE VOMITING OBSTRUCTION PROSTRATION	X-RAY	ABDOMINAL	ENTIRE STOMACH LARGE AND SMALL BOWEL	LEFT FORAMEN BOCHDALEK	ETHER ETHYLENE INTRATRACHEAL	DIED	PERSONAL COMMUNICATION
39	1930	HARRINGTON[41] U.S.A.	3YR. M.	CONGENITAL	VOMITING	X-RAY	ABDOMINAL	PORTION OF STOMACH	LF. THRU ESOPH. HIATUS	ETHYLENE	LIVED	PERSONAL COMMUNICATION POS. PRESSURE ANESTHESIA ALWAYS AVAILABLE IF NEC.
40	1931	DONOVAN[42] U.S.A.	4 MO. M.	CONGENITAL	DYSPNEA CYANOSIS PAIN CONVULSIONS	X-RAY	ABDOMINAL	SMALL INTESTINES TRANS. COLON SPLEEN	LEFT POST.	POSITIVE PRESSURE ETHER	LIVED	PERSONAL COMMUNICATION
41	1931	BETTMAN AND HESS[43] U.S.A.	9MO. F.	CONGENITAL	VOMITING DYSPNEA COLICKY PAIN	X-RAY	COMBINED	SMALL INTESTINES	LEFT DOME	POS. PRESSURE ETHYLENE O_2 ETHER	LIVED	
42	1931	EGGERS[44] U.S.A.	4 WKS. F.	CONGENITAL	DYSPNEA CYANOSIS PAIN WEIGHT LOSS	X-RAY	ABDOMINAL	STOMACH PART OF COLON - SPLEEN TIP OF LIVER	LF. LARGE EVEN-TRATION	GENERAL	DIED	TIP OF LIVER COULD NOT BE WITHDRAWN, LEFT IN
43	1931	ROBB[45] U.S.A.	7 WKS. M.	CONGENITAL	DYSPNEA CHOKED WHEN NURSING	X-RAY	ABDOMINAL	STOMACH SMALL INTESTINES MOST OF COLON	LEFT POST.	NOT RECORDED	LIVED	OPERATED BY DR. O.S. WYATT
44	1931	CORYLLOS[46] U.S.A.	13 DA. F.	CONGENITAL	VOMITING DYSPNEA CYANOSIS	X-RAY	COMBINED	MOST OF G.I. TRACT SPLEEN	LF. POST. FORAMEN BOCHDALEK	INTRATRACHEAL O_2 ETHER	LIVED	
45	1931	HIPSLEY[47] AUSTRALIA	10YR. F	CONGENITAL	VOMITING ATTACKS OF ABD. PAIN	X-RAY	ABDOMINAL	HALF STOMACH IN SAC	LF. ESOPH. HIATUS SAC	OPEN ETHER	LIVED	PHRENIC N. CRUSHED
46	1931	UNSHELM[48] GERMANY	9 MO. M.	CONGENITAL	VOMITING MALNUTRITION ANEMIA	X-RAY	ABDOMINAL	STOMACH SPLEEN	LEFT ESOPH. HIATUS	CHLOROFORM ETHER	DIED	
47	1931	STEPHENS[18] AUSTRALIA	6YR. M.	CONGENITAL	VOMITING PAIN DIARRHEA	X-RAY	THORACIC	SMALL INTESTINES COLON SPLEEN	LEFT LATERAL POST.	INTRATRACHEAL ETHER	LIVED	
48	1932	JOHNSON AND BOWER[49] U.S.A.	41 HR. M.	CONGENITAL	DYSPNEA CYANOSIS OBSTRUCTION	X-RAY	COMBINED	COLON AND OMENTUM	LEFT DOME	ETHER	LIVED	
49	1932	IIZUKA AND SANO[50] JAPAN	8 MO. F.	CONGENITAL	VOMITING DYSPNEA CYANOSIS	X-RAY	ABDOMINAL	MOST OF G.I. TRACT	LEFT POST. LAT.	LOCAL	LIVED	
50	1932	LAUENSTEIN[51] GERMANY	9 MO. M.	CONGENITAL	VOMITING CONSTIPATION OBSTRUCTED 8 DAYS	X-RAY	ABDOMINAL	MOST OF SMALL INTESTINES	LEFT	NOT RECORDED	DIED	

A word should be said here regarding the diagnosis. In any case showing the above symptoms, the physical examination may reveal tympany on percussion of the side involved; dextrocardia; dulness to flatness on percussion on the side involved; absent or diminished breath sounds on the involved side; râles, diminished excursion on the involved side, retraction of the abdomen; an epigastric mass; a rapid heart beat.

No diagnosis can be considered complete, however, without the *x*-ray, and unless the presence of a diaphragmatic hernia is suspected, it is usually not diagnosed unless an *x*-ray examination is made. We feel we cannot stress too strongly the importance of an *x*-ray in any child suffering from persistent or repeated attacks of dyspnea, cyanosis, vomiting, pain, cough, choking spells, or gastrointestinal upsets. A glance at Table 1 immediately reveals the importance of the *x*-ray. In sixty of the sixty-eight cases, the *x*-ray was used either to make or confirm a diagnosis. A correct diagnosis was made in all except four of these cases. One proved to be a

51	1933	BRYCE AND GRAY[62] ENGLAND	7 YR. M.	TRAUMATIC FELL FROM BICYCLE	VOMITING ABD. PAIN MILD FEBRILE ATTACKS WITH COUGH	X-RAY	THORACIC	STOMACH COLON SPLEEN	LEFT SAC PRESENT	INTRATRACHEAL GAS O, ETHER	LIVED	
52	1934	PIERRET AND BRETON[63] FRANCE	7 YR. M.	CONGENITAL	PAIN IN RT. LOWER THORAX LOSS OF WEIGHT	X-RAY	ABDOMINAL	TRANSVERSE COLON	RT. MEDIAN ANTERIOR NO SAC	NOT RECORDED	LIVED	OPERATED BY COURTY
53	1934	BARRETT[64] AND WHEATON ENGLAND	4½ MO. M.	CONGENITAL	VOMITING CYANOSIS CONSTIPATION	X-RAY	ABDOMINAL	MOST OF G.I. TRACT, SPLEEN	DEFICIENCY OF L.F. DOME	OPEN ETHER	DIED	OPERATED BY MR. MAX PAGE OBSTRUCTED 10 DAYS LATER ILEOSTOMY BY BARRETT
54	1934	ORR AND NEFF[6] U.S.A.	27 DA. M.	CONGENITAL	DYSPNEA CYANOSIS EMPTINESS OF ABDOMEN	X-RAY	COMBINED	SMALL INTESTINES PORTION OF COLON	LEFT LATERAL	POSITIVE PRESSURE NITROUS OXIDE O,	LIVED	
55	1935	TRUESDALE[5] U.S.A.	10 YR. F.	CONGENITAL	VOMITING COUGHING DYSPNEA CYANOSIS	X-RAY	THORACIC	MOST OF G.I. TRACT SPLEEN EDGE OF LIVER	LEFT DOME	POSITIVE PRESSURE GAS O, ETHER	LIVED	
56	1935	TRUESDALE[5] U.S.A.	9 YR. M.	CONGENITAL	VOMITING	X-RAY	THORACIC	MOST OF G.I. TRACT, SPLEEN	LEFT DOME LATERALLY	POSITIVE PRESSURE GAS O, ETHER	DIED	POST MORTEM DEATH DUE TO ASPHYXIA
57	1935	WEINBERG AND HAMILTON[65] U.S.A.	5 MO. M.	CONGENITAL	DYSPNEA DIFFICULTY IN NURSING	X-RAY	ABDOMINAL	STOMACH ALL SM. INTESTINES AND COLON SPLEEN L.F. ADRENAL	LEFT POST. LATERAL	LOCAL ETHER POS. PRESSURE NITROUS OXIDE O,	LIVED	PT. STOPPED BREATHING CHANGED TO POSITIVE PRESSURE GAS O,
58	1935	STEPHENS[19] AUSTRALIA	5 YR. M.	CONGENITAL	ANEMIA PERSISTENT IN SPITE OF 2 YR. TREATMENT	X-RAY	THORACIC	STOMACH IN PERITONEAL SAC	RT. ESOPH. HIATUS SAC	POSITIVE PRESSURE	LIVED	OPERATED BY DR. OSBORN OPENING COULD NOT BE SATISFACTORILY CLOSED
59	1935	HIMPRISS[66] ENGLAND	14 MO. F.	CONGENITAL	VOMITING GRADUAL INCREASE IN FREQUENCY AND SEVERITY	X-RAY	ABDOMINAL	MOST OF STOMACH IN A SAC	RIGHT ESOPH. HIATUS	NOT RECORDED	DIED	OPERATED BY MR. MAX PAGE RECURRENCE IN 5 MO. REOPERATED DIED
60	1936	DONOVAN[17] U.S.A.	3 YR. F.	CONGENITAL	TREATED FOR ADVANCED PULMONARY T. B.	X-RAY	ABDOMINAL	STOMACH - ALL SMALL INTESTINES - MOST OF COLON - SPLEEN	LEFT FORAMEN BOCHDALEK	POSITIVE PRESSURE ETHER	LIVED	PERSONAL COMMUNICATION
61	1936	BIRD[18] U.S.A.	8 YR. M.	TRAUMATIC FELL FROM ROOF 5 YRS. BEFORE	VOMITING INDIGESTION DIARRHEA - LATER OBSTRUCTION	X-RAY	THORACIC	ALL SMALL INTESTINES ½ COLON SPLEEN	LEFT ANTERIOR OF DOME	ETHER	LIVED	PRELIMINARY EXPLORATORY LAPAROTOMY
62	1937	STOBIE[20] CANADA	4 YR. M.	TRAUMATIC CRUSHED UNDER STONE BOAT	VOMITING DYSPNEA PAIN IN L.F. CHEST	X-RAY	THORACIC	STOMACH	LEFT DOME	NITROUS OXIDE ETHER	LIVED	NOT POSITIVE PRESSURE PERSONAL COMMUNICATION
63	1938	HARRINGTON[60] U.S.A.	8 YR. M.	TRAUMATIC RUN OVER BY CAR	ABDOMINAL DISTRESS AFTER MEALS	X-RAY	ABDOMINAL	ENTIRE STOMACH TRANSVERSE COLON SM. BOWEL SPLEEN	LEFT ESOPH. HIATUS	GAS ETHER	LIVED	PERSONAL COMMUNICATION POS. PRESSURE ANESTHESIA ALWAYS AVAILABLE IF NEC.
64	1938	HARRINGTON[60] U.S.A.	3 YR. M.	CONGENITAL	VOMITING	X-RAY	ABDOMINAL	ENTIRE STOMACH ASCEND. COLON - MANY LOOPS SM. BOWEL - SPLEEN	L.F. PLEURA PERITONEAL HIATUS	GAS ETHER	LIVED	PERSONAL COMMUNICATION POS. PRESSURE ANESTHESIA ALWAYS AVAILABLE IF NEC.
65	1938	HARRINGTON[60] U.S.A. 1	3 YR. M.	CONGENITAL	VOMITING PAIN IN CHEST	X-RAY	ABDOMINAL	ENTIRE STOMACH TRANSVERSE COLON SM. BOWEL SPLEEN	LEFT, ½ DIAPHRAGM ABSENT	ETHYLENE GAS ETHER	LIVED	PERSONAL COMMUNICATION POS. PRESSURE ANESTHESIA ALWAYS AVAILABLE IF NEC
66	1938	HARRINGTON[60] U.S.A.	6 YR. M.	CONGENITAL	VOMITING	X-RAY	ABDOMINAL	¾ OF STOMACH	POST. MEDIAN ESOPH. HIATUS	CYCLOPROPANE ETHER	LIVED	PERSONAL COMMUNICATION POS. PRESSURE ANESTHESIA ALWAYS AVAILABLE IF NEC
67	1938	HARRINGTON[60] U.S.A.	10 YR. F.	TRAUMATIC AUTO ACCIDENT	COLICKY PAINS	X-RAY	ABDOMINAL	STOMACH - TRANS. COLON PORTION SMALL BOWEL SPLEEN L.F. LOBE LIVER	LEFT TRANSVERSE TEAR	CYCLOPROPANE ETHER	LIVED	PERSONAL COMMUNICATION POS. PRESSURE ANESTHESIA ALWAYS AVAILABLE IF NEC
68	1937	HARTZELL U.S.A.	21 YR. F.	TRAUMATIC STRUCK BY TRUCK	DYSPNEA CYANOSIS - PAIN IN L.F. CHEST L.F. UPPER QUADRANT SHOCK	X-RAY	ABDOMINAL	ALL STOMACH SM. BOWEL COLON L.F. LOBE LIVER PART OF SPLEEN	LEFT DOME	INTRATRACHEAL POSITIVE PRESSURE	LIVED	L.F. PHRENIC N. CRUSHED FRACTURE RT. HUMERUS

small and unusual type of eventration, the other three were deficiencies in the diaphragm. It is interesting to note that several patients were treated for considerable periods of time for other conditions, and a correct diagnosis was not made until *x*-ray studies had been completed. In five of the eight cases where the *x*-ray was not used, the diagnosis was definitely missed.

TABLE II

Male—37 54.4 Per Cent		Female—28 41.2 Per Cent		Sex Not Recorded—3 4.4 Per Cent	
Lived	Died	Lived	Died	Lived	Died
27 72.9 per cent	10 27.0 per cent	18 64.2 per cent	10 35.7 per cent	1 33.3 per cent	2 66.7 per cent

TABLE III
RELATIVE FREQUENCY OF SYMPTOMS

Symptom	Entire Series 68 Cases	Traumatic 14 Cases	Congenital and Acquired Cases		All Cases over 1 Yr. 44 Cases
			Over 1 Yr. 30 Cases	Under 1 Yr. 24 Cases	
Vomiting	34	3	19	12	22
Dyspnea	24	5	2	17	7
Pain-colic	24	6	12	6	18
Cyanosis	18	2	1	15	3
Obstruction	11	2	7	2	9
Constipation	7	..	5	2	5
Loss of weight	7	..	3	4	3

If one could be certain before operation that a congenital deficiency of the diaphragm was present, it would probably be better to treat the case expectantly than to attempt repair. Of the three cases with diaphragmatic deficiencies reported in this series, two died and one was successfully repaired. LeWald[61] reports three cases of congenital absence of the left half of the diaphragm. He believes the condition does not lend itself to surgical repair. Beckman[62] reports a case of supposed diaphragmatic hernia operated by W. J. Mayo in 1909. A large deficiency was found, no repair was attempted. The patient recovered. Hume[63] believes congenital absence of the left half of the diaphragm is usually incompatible with life.

It is generally felt also, that eventrations should not be operated upon. Clopton[64] reports two cases of eventration. He states diagnosis may be made by fluoroscopic and *x*-ray studies. The diaphragm moves with respiration, though less than normally, due to hypoplasia of the left lung. It may be confused with situs transversus from the fact that the heart is on the right side. The stomach will be on the left side, however. Lateral *x*-ray and fluoroscopic studies are particularly valuable. From this angle the diaphragmatic dome may be visible. He feels the prognosis is good under medical management, and that surgical measures should not be attempted.

Hume's[63] patient, a 6 year old boy struck by a truck, was not operated upon. A left thoracentesis was performed, and air and brown fluid obtained (presumably gas and intestinal contents). The patient died a few hours later, and necropsy revealed a left diaphragmatic hernia with the stomach, colon and omentum in the left thoracic cavity. The author believed this to be a congenital hernia. The child was almost moribund, and there is little question that nothing could have altered the fatal outcome. With the sudden and sometimes almost overwhelming respiratory and cardiac embarrassment which may follow such a traumatic injury, a massive thoracic hemorrhage, effusion, or a tension pneumothorax might have to be considered.

A thoracentesis was performed on Reiss'[65] 3 year old patient, and upon the twenty-two month old infant reported by Giustinian.[66] Death followed shortly afterward in each instance. Three taps were made in Brush's[67] case and twelve in De la Vega's[68] before the diagnosis was made. In one case in this series, reported by Olmstead,[34] a thoracentesis was performed before the diagnosis was made. Later, after the diagnosis had been made by *x*-ray, an operation for repair was performed.

The diagnosis is sometimes difficult, as has been well brought out by the researches

of Woolsey,[9] and Greenwald and Steiner.[8] Physical examination is often difficult and will not always reveal the real trouble.

Fig. 2. Preoperative *x*-ray showing absence of left diaphragm shadow and barium-filled small intestine in left thorax with gas-filled stomach above.

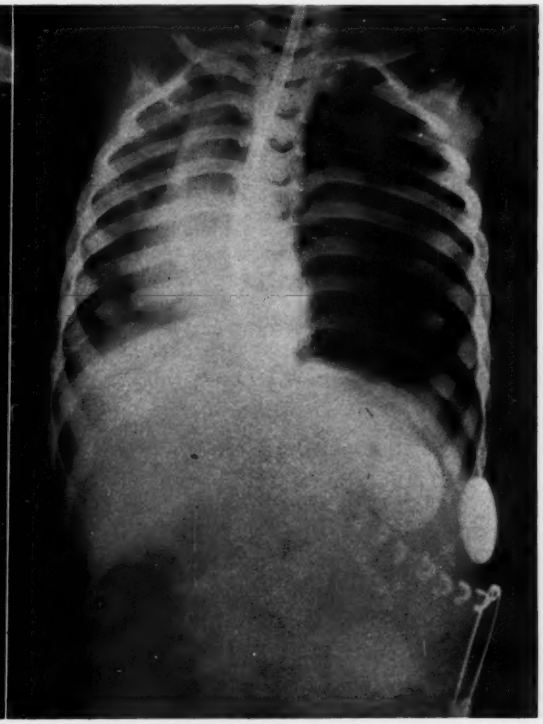

Fig. 3. Twenty-four hours postoperative. Note diaphragm shadow on the left side and left pneumothorax. The mediastinum has shifted to the right. There is no evidence of any abdominal viscera in the thorax. The small stomach catheter is still in place.

From a study of this series of cases, we feel the necessity of early and adequate roentgenologic study cannot be too strongly emphasized.

Since the first operation to be performed on a child nearly fifty years ago, the mortality has gradually decreased. This change has been largely due to several definite factors: (1) Earlier correct diagnosis, which means in substance improvement in roentgenologic technique, and the more frequent use of the *x*-ray. (2) Improvement in the anesthesia, i.e., better and less toxic anesthetic agents, better methods of administration, the simple closed method and the intratracheal tube which allows the anesthetist to administer positive pressure when the need arises. (3) Adequate preparation of the patient for the operation, which is now less often performed as an emergency measure. The patient's general condition may often be improved and anemia overcome by frequent small feedings, blood transfusions, etc. (4) General improvement in the technique has been derived mainly from those who have pioneered in this field.

The following are some of the advances which aid us in the correct handling of these cases. (1) The lavaging of the stomach by passing a small tube preoperatively, as stressed by W. Meyer,[35] is important. In the presence of a diaphragmatic hernia the stomach may not empty readily, and a retention may be present. With the replacement of the stomach in the abdomen, some of the gastric content may regurgitate, and be aspirated by the patient. (2) The crushing of the phrenic nerve, as advocated by Harrington,[69] aids in the repair by supplying a quiet and relaxed diaphragm. (3) The introduction of a stomach tube into the thoracic cavity via

the abdominal incision and the hernial opening in the diaphragm, as first advocated by C. H. Mayo,[70] allows air to be introduced above the viscera, and destroys the suction which may make their withdrawal difficult. (4) The cutting or breaking of the ribs (first advocated by C. H. Mayo,[70] Carrington,[71] Harrington,[72] and recently described by Bird[58]), may aid in the repair. If the diaphragm is torn from the chest wall, or if the opening cannot be closed because of tension, this procedure will relax the diaphragm sufficiently to provide enough tissue to accomplish the repair. (5) The aspiration of the pneumothorax postoperatively does much toward relieving the cyanosis and dyspnea which follows the shift of the heart and the mediastinum to the unaffected side at the time of the operation.

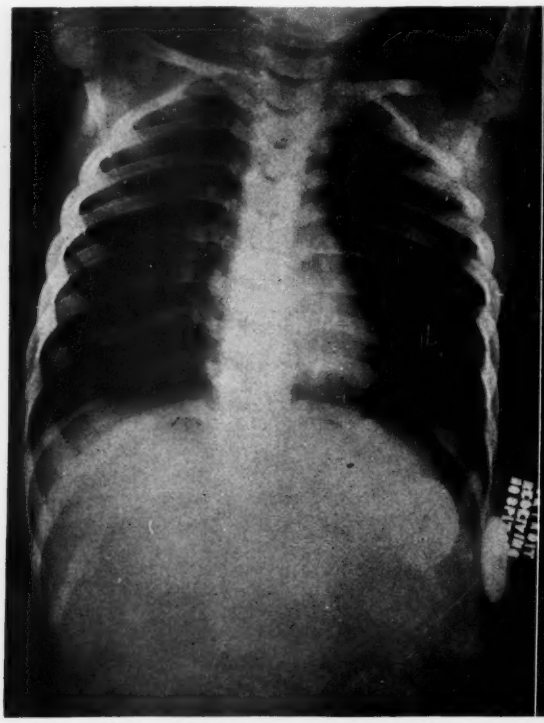

Fig. 4. One week postoperative. Complete outline of left diaphragm shadow but still about 60 per cent collapse of the left lung.

Fig. 5. Two weeks postoperative. Complete diaphragm outline and almost complete expansion of left lung visible.

Table IV

Years	No. Cases	No. of Deaths	Per Cent Mortality
1889–1920	9	5	55.5
1921–1930	23	11	47.8
1931–1938	36	6	16.7

We believe the abdominal approach is usually the best. It seems reasonable to state that no one would favor the combined approach unless necessity demanded it. In children where the hernia has usually not been present for a long period of time, and where adhesions between the displaced abdominal viscera and the parietal pleura are rarely encountered, the abdominal approach seems more simple. Harrington's[4] enviable record of 120 cases of all types and ages, with ten deaths (mortality 8.3 per cent), seems to bear this out. However, in this series the mortality is definitely higher in those cases operated on by the abdominal route. It is unquestionably true that in a statistical study on such a small series of cases, and in one embracing a long period of years, there is grave danger of drawing false conclusions. However, a study of

these cases would lead one to suppose that the higher mortality encountered in the group operated on via the abdominal approach might be partially explained by the fact that from 1889 to 1920 only nine cases reached operation. The mortality during these years was nearly three times as great as during the past decade, and all but one of these patients were operated on via the abdominal route.

Fig. 6. Fifteen days postoperative.

It is of vital importance to have a correct diagnosis before subjecting the patient to operation. In those cases where the diagnosis was not made preoperatively, and where the surgeon proceeded with the repair of the hernia after discovering it at the time of an exploratory operation, the mortality (80 per cent), is exceedingly high. If a diaphragmatic hernia is found during an exploratory laparotomy, it would seem to be good judgment to close the abdomen without repairing it. Then, at a later date, with adequate preparation, a blood transfusion and an anesthetist equipped to administer positive pressure anesthesia, the hernia repair may be attempted. The truth of this statement would seem to be borne out by the fact that the two patients in whom the diagnosis was not made until exploration, and where repair was done at a subsequent operation, survived.

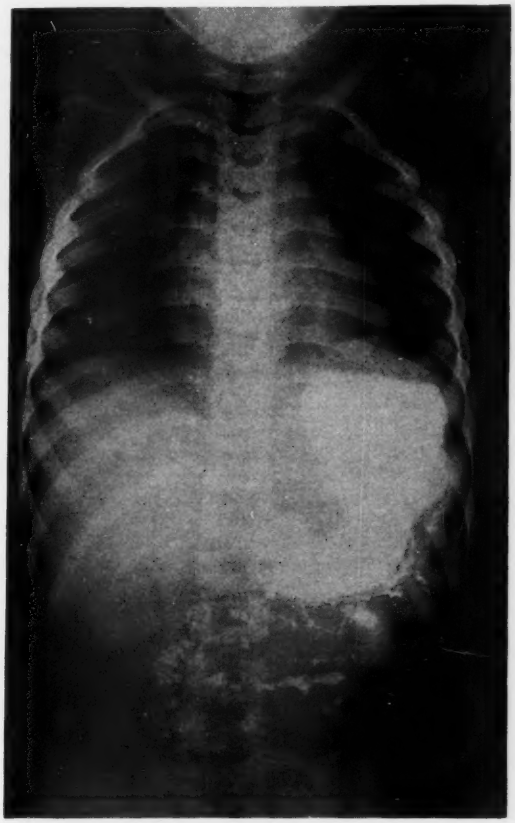

Fig. 7. Eight months postoperative. Normal diaphragm outline and barium-filled stomach in normal position.

We believe the anesthetist should always be prepared to administer a positive pressure anesthesia if the need arises. Many authors stress the importance of this statement. Harrington[4] feels that in the case of a true hernia where a sac is present, the ordinary ethylene or cyclopropane closed anesthesia is satisfactory. However, in the false hernia where no sac is present, it is of great importance to be able to administer positive pressure. The truth of this statement is well verified. (Table vii.)

The higher mortality encountered in the group operated on via the abdominal approach (Table v), would appear to result

at least partially from the fact that more cases were operated on by this method without the benefit of positive pressure anesthesia. Certainly the 7.7 per cent mortality in those operated on by the abdominal route, where it is known that a preoperative diagnosis was made, and a proper anesthesia administered, is satisfactory.

Most authorities agree that the mortality in children is higher than in adults. The total mortality in this series of sixty-eight cases is 32.4 per cent. A study of the mortality with relation to the age of the patient reveals that it is definitely higher during the first year of life. The twenty-four cases under one year of age were all congenital, and the mortality was 50 per

TABLE V

All Cases			Thoracic			Combined			Abdominal		
No. Cases	Mortality		No. Cases	Mortality		No. Cases	Mortality		No. Cases	Mortality	
	No.	Per Cent		No.	Per Cent		No.	Per Cent		No.	Per Cent
68	22	32.4	19	5	26.3	9	1	11.1	40	16	40.0

TABLE VI

When Diagnosed	All Cases			Thoracic			Combined			Abdominal		
	No. Cases	Mortality		No. Cases	Mortality		No. Cases	Mortality		No. Cases	Mortality	
		No.	Per Cent		No.	Per Cent		No.	Per Cent		No.	Per Cent
Before operation.....	63	18	28.6	18	4	22.2	9	1	11.1	36	13	36.1
At operation.....	5	4	80.0	1	1	100	..	..	....	4	3	75.0

TABLE VII

Anesthesia	All Cases			Thoracic			Combined			Abdominal		
	No. Cases	Mortality		No. Cases	Mortality		No. Cases	Mortality		No. Cases	Mortality	
		No.	Per Cent		No.	Per Cent		No.	Per Cent		No.	Per Cent
Positive pressure anesthesia.....	30	4	13.3	13	3	23.1	6	..	....	13	1	7.7
Other types of anesthesia or not recorded...	38	18	47.3	6	2	33.3	3	1	33.3	27	15	55.5

cent. After the first year the mortality dropped to 22.7 per cent. In this group of from 1 to 10 years of age, it will be seen that in the congenital and acquired cases it is about four times as great as in the traumatic cases.

type. In this table it is seen that by far the most common location is through the left diaphragm. Most of these are false hernias without sacs. There was one eventration which was operated upon and a repair attempted. This was, however, localized to the central portion of the diaphragm, and could almost be considered as a true hernia. There were also three cases where a

TABLE VIII

Age of Patient	Entire Series 68 Cases			Congenital and Acquired 54 Cases			Traumatic 14 Cases		
	No. Cases	Mortality		No. Cases	Mortality		No. Cases	Mortality	
		No.	Per Cent		No.	Per Cent		No.	Per Cent
Under 1 yr.	24	12	50.0	24	12	50.0	..	..	...
1–10 yrs.	44	10	22.7	30	9	30.0	14	1	7.1

TABLE IX

Location	Entire Series 68 Cases			Congenital and Acquired						Traumatic 14 Cases		
				Under 1 Yr. 24 Cases			Over 1 Yr. 30 Cases					
	No. Cases	Mortality		No. Cases	Mortality		No. Cases	Mortality		No. Cases	Mortality	
		No.	Per Cent		No.	Per Cent		No.	Per Cent		No.	Per Cent
Through left diaphragm	48	15	31.2	20	8	40.0	17	6	35.3	11	1	9.09
Through right diaphragm	1	..	....	..	..	....	1	..	....	..	..	....
Esophageal hiatus—left	11	2	18.2	1	1	100	7	1	14.3	3		
Esophageal hiatus—right	3	2	66.7	..	..	....	3	2	66.7	..	..	....
Esophageal hiatus—post mediastinum	1	..	....	..	..	....	1	..	....	..	..	....
Eventration left diaphragm	1	1	100	1	1	100		..	....	..	..	....
Congenital deficiency or absence left diaphragm	3	2	66.7	2	2	100	1	..	....	..	..	....

Table IX gives the incidence of the location of the hernia, and the percentage mortality with relation to the location and

deficiency of the left diaphragm was present. One was described as a complete absence, the other two as deficiencies.

mortality to which organs are displaced into the chest, a study of Table x reveals that there is little relationship between

TABLE X

Viscera Present in Thorax	Entire Series 68 Cases				Traumatic 14 Cases				Congenital and Acquired 54 Cases							
									Under 1 Yr. 24 Cases				Over 1 Yr. 30 Cases			
	Cases		Mortality		Cases		Mortality		Cases		Mortality		Cases		Mortality	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Stomach....	48	70.6	14	29.2	11	16.2	..	....	13	19.1	7	53.8	24	35.3	7	29.1
Colon.....	48	70.6	14	29.2	11	16.2	..	....	18	26.5	7	38.9	19	27.9	7	36.8
Small bowel.	44	64.7	17	38.6	8	11.7	1	12.5	20	29.4	9	45.0	16	23.5	7	43.7
Spleen.....	28	41.2	9	32.1	9	13.2	1	11.1	9	13.2	5	55.5	10	14.7	3	30.0
Omentum...	11	16.2	3	27.3	4	5.9	1	25.0	3	4.4	1	33.3	4	5.9	1	25.0
Left lobe of liver.....	5	7.3	..	....	5	7.3	..	....	..	....	..	....	..	....	..	....
Edge of liver	2	2.9	1	50.0	..	....	..	....	1	1.4	1	100	1	1.5	..	....

Regarding the relationship of the "contents of the hernia" to the mortality, rather one should say, the relationship of the which viscera are present in the thorax, and the mortality, except in the case of the small bowel. The presence of the small bowel definitely increases the mortality figure. This is more clearly shown in Table xi. If small bowel is present in the thorax, the mortality is nearly twice as great as when it is not present. A study of Table 1 reveals, however, that the stomach, colon, small intestine, or some combination of the three is present in all of the sixty-eight cases. They seem to be the important organs to consider.

Table xi

Viscera Present in Thorax	No. Cases	Mortality	
		No.	Per Cent
Small bowel without stomach and colon.....	6	5	83.3
Small bowel and stomach	2	1	50.0
Small bowel with stomach and colon.....	26	9	34.6
Colon and stomach.....	8	2	25.0
Colon without small bowel, stomach.....	4	1	25.0
Small bowel and colon...	10	2	20.0
Stomach without small bowel, colon.....	12	2	16.7
Summary of Table			
Small bowel with or without other viscera.....	44 (64.7%)	17	38.6
Other viscera without small bowel.....	24 (35.3%)	5	20.8

The presence or absence of the spleen, omentum or liver, seems to have little bearing upon the outcome. One might suppose that the presence of the entire left lobe of the liver might produce greater cardiac and pulmonary embarrassment. However, all five of these cases are traumatic, and over 1 year of age, and all lived. This brings up the possibility that the presence of the left lobe of the liver in the left thoracic cavity means that the rent in the diaphragm is large and less likely to

compress the bowel. Also, with the left lobe of the liver in the thorax, there is certainly less room for bowel to protrude into it. We consider the presence or absence of the omentum as unimportant. Some authors have experienced some difficulty with hemorrhage in removing the spleen.

CONCLUSIONS

The operation for the repair of the diaphragmatic hernia is still a relatively rare surgical procedure in children. This paper reports and analyzes sixty-eight such cases which have occurred in the course of the past fifty years. The diagnosis of diaphragmatic hernia is more frequently made in the male than in the female, and the operative mortality is higher in the latter. The most common type is the false hernia through the left diaphragm.

A diaphragmatic hernia constitutes a menace to the life of the patient. Early diagnosis is essential. In many cases where the hernia is the cause of death, the diagnosis is not made until the autopsy is performed. A routine post-mortem *x*-ray in infants and young children in unexplained deaths, might reveal a higher incidence of diaphragmatic hernia then is at present suspected. Due to improved roentgenologic technique, many more cases are diagnosed during life than formerly. More cases have been operated upon during the past eight years than in the previous forty. In many cases in this series, the diagnosis was not made until the *x*-ray was taken. We therefore believe that we cannot stress too strongly the importance of early roentgenologic studies.

Under 1 year of age, dyspnea, cyanosis, and vomiting are the most frequently listed symptoms, while over 1 year, vomiting, pain, and obstruction occur more often. The mortality is higher during the first year of life. The presence of the small bowel in the thorax, increases the mortality figure, as do signs of a partial or complete obstruction.

A preoperative diagnosis is essential. This allows for proper preparation, first with regard to the patient's general condition, and second with regard to the preparation for the operation itself. Crushing the phrenic nerve, lavaging the stomach, preparation for the administration of positive pressure anesthesia, are all important.

Except in the case of a symptomless infant under 1 year of age, a definite diagnosis of a diaphragmatic hernia should be followed by a surgical repair at the earliest opportunity.

The following is a case report of a diaphragmatic hernia which was successfully repaired, and which illustrates some of the points brought out in this paper.

CASE REPORT

The patient was a white female child of 2½ years, who twenty minutes before admission to the hospital was struck on the left side by a truck. In addition to a fracture of the right humerus, she had many abrasions over the head, abdomen, and left upper thigh. Her condition appeared quite critical, as her blood pressure was 64/30, her pulse was over 160, temperature subnormal, and her respirations labored and rapid. The chest was wrapped in bandages, which provided temporary fixation to the right humerus, and was therefore not examined. The abdomen was soft, but quite tender, especially over the left side. Peristalsis was normal. Owing to the lack of other physical findings in the abdomen, we felt that there was a good possibility that the injury in this area was localized to the abdominal wall.

The child was treated by intravenous injections of 5 per cent glucose, and local heat applications. She gradually recovered from her shock. Her white count was 19,550, hemoglobin 9.6 Gm., and her urine contained an occasional white cell and a moderate number of red cells. By the following morning it was evident, despite persistent voluntary rigidity, that there was little likelihood of a ruptured viscus, and the child was allowed fluids. Her improvement permitted further study, and it was found that there was gas shadows within the left lung field, as seen by *x*-ray, and a diagnosis was made of herniation of the stomach and much of the bowel through the left diaphragm. The respirations remained rapid and the temperature was persisted elevated from 1 to 3 degrees.

The question arose concerning immediate repair of the hernia, but the child's condition indicated that this would be more dangerous than advantageous. Since there was small bowel present in the hernia, it was thought best that the child be operated as soon as her condition warranted, rather than wait until she was older, because of possibility of intestinal obstruction.

She was placed on multiple small feedings, and by the second week was up and about the ward. Five weeks after the accident, she appeared quite normal, her humerus was united in good position, and her blood picture was normal. The left phrenic nerve was crushed, and produced paralysis of the left hemidiaphragm.

Three weeks later when the child appeared in good condition, repair of the hernia was undertaken. Preoperative preparation consisted of aspiration of the stomach content through a nasal catheter which was left in place, and a transfusion of 200 c.c. of citrated blood. We were fortunate in having available a well trained anesthetist, Dr. Frank Murphy, to whom thanks are due for a well administered positive pressure anesthesia.

A left subcostal incision was made. Exploration revealed the stomach, most of the small intestine, the transverse splenic flexure of the colon, and the upper third of the spleen within the left thoracic cavity. This was withdrawn, and the rent in the diaphragm was picked up with forceps. It was about 7 cm. long. A loop of small intestines (which appeared to be the duodenum) was firmly adherent to the lower flap. This was dissected free. The lower flap of the diaphragm was then sutured to the superior surface of the upper flap 1 inch from the free margin with interrupted mattress sutures of silk. The free margins of the upper flap were then sutured to the inferior surface of the lower flap with interrupted sutures of silk. There was a slight amount of oozing from the area just above the pancreas, and this was controlled with a single iodoform pack.

The patient stood the operation well. On her return to the ward she was quite cyanotic, and was placed in an oxygen tent. The pulse was 130 to 150, the respirations 30 to 50, and the temperature as high as 102 degrees. A second 250 c.c. transfusion was given later in the day, supplemented by 200 c.c. of saline. Carbon dioxide and oxygen inhalations were given every three hours. On the following day her condition remained about the same. So much difficulty was encountered in the administration of intravenous fluid, that hypodermoclysis was begun. She was also given 100 c.c. retention enemas of warm tap water every four hours. On the following day, as the patient refused fluids, a nasal catheter was inserted, and water, 1 to 2 ounces every hour, was introduced into the stomach through the tube, and she was given hard candy to suck. On the next day a formula was made up and injected through the tube. A portable *x*-ray showed 70 per cent collapse. We considered aspirating some of the air from the left thorax, but she seemed to be doing so well, that it was thought best to leave her alone. The pack was removed on the fourth day. By the fifth day the patient was taking nearly 1,000 c.c. of fluid by mouth, and the nasal catheter was removed. From then on her convalescence was uneventful. *X*-rays showed gradual expansion of the left lung.

Within two weeks from the date of operation she was able to be out of bed. She was last seen ten months after the operation, at which time she appeared quite normal and healthy.

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. . . The treatment of choice in cases of acute massive hemothorax is immediate aspiration of the hemothorax followed by injection of air. Where there is a moderate amount of blood in the pleural cavity, recovery will follow expectant treatment or aspiration and air replacement, but the latter treatment shortens the convalescence.

PITFALLS OF PHRENIC NERVE CRUSHING

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IT seems puerile to discuss so simple an operation as phrenic nerve crushing. However, like many other simple procedures, its potential complications are so great that they should be frequently emphasized. There is no thoracic surgeon who has not at one time or another been quite taken aback and embarrassed by dallying a considerable time on a phrenic crushing which he had expected to complete in a few minutes. Very often the difficulties are self-made—the outcome of an error of omission or commission in the technical procedure, resulting in the destruction of essential landmarks or in the creation of false ones which eventually lead to major trouble.

As a rule, a 1 or 1½ inch transverse incision, about 1 inch above the clavicle just over the posterior border of the sternomastoid muscle will give a sufficient exposure to identify and crush the phrenic nerve. Care in identifying and preserving the landmarks is essential to a successful operation.

The posterior border of the sternomastoid is easily recognized by palpation upon having the patient raise and turn his head slowly from side to side.

The incision is carried through the platysma and the border of the sternomastoid is then retracted medially, exposing the cervical fascia which covers a pad of fat immediately overlying the scalenus anticus. The fascia should be incised transversely across the muscle and the fat then bluntly separated with a hemostat in the direction of the muscular fibers in order not to disturb the relationship of the nerve to the muscle. This fat layer is very vascular and care should be taken not to tear any vessels and obstruct the field. The nerve is generally seen just lateral to the medial border of the scalenus anticus, running obliquely downward. If this fails to expose the nerve, blunt dissection should be carried upward to the omohyoid muscle crossing. The scalenus muscle is palpated as a stout band and not infrequently the phrenic can be felt coursing along it immediately behind the omohyoid.

The phrenic, which varies in size, is generally easily identified by the pain felt in the shoulder and neck when it is squeezed with a forceps, although this does not always apply because the nerve is sometimes anesthetized or because the pain is produced only upon crushing. Crushing the nerve at one point with a toothless clamp usually suffices to paralyze the diaphragm for four to six months.

The incision is closed with skin clips or silk sutures which are removed in twenty-four hours to insure a good cosmetic result.

When performed as described, the operation takes ten to twenty minutes. Pitfalls may prolong the operation indefinitely, sometimes render it impossible, and occasionally lead to dire complications.

One of the most common difficulties is brought about by the retraction of the nerve with the cervical fascia and fat pad with the retractors. A fruitless search ensues which opens the door to confusion and danger. The sympathetic nerve, which generally lies behind the jugular vein medial to the scalenus, is mistaken for the phrenic and crushed. The result is a Horner's syndrome which lasts for months and sometimes is permanent. On occasion this may lead to an ulcer of the cornea.

The carotid sheath may unintentionally be opened, the vagus exposed and deliberately or inadvertently crushed, producing a paralysis of the muscles supplied by the recurrent laryngeal nerve and an

increase in the cardiac rate. The recurrent laryngeal itself has been injured with consequent hoarseness of several months' duration. In one case that has come to our attention (a doctor), it lasted for eight months. This was accompanied by a dryness of the throat which was very harassing to the patient.

The brachial plexus, which is often an important landmark for the lateral border of the scalenus anterior, is not infrequently traumatized, producing considerable disability and pain in the arm.

The long thoracic nerve, which bears a similar relationship to the scalenus medius that the phrenic does to the anticus, has been confused with it because the medius was taken for the anticus.

The brachial plexus proper is not often mistaken for the phrenic because it is much larger, but the subclavian branch which runs parallel to the phrenic on the lateral border of the scalenus anticus is frequently crushed instead of the phrenic. However, injury to the brachial plexus resulting from this operation has been reported several times, probably due to pressure from retraction.

Hemorrhages of considerable severity occur from injury to the jugular and subclavian veins and thyroid axis. Some of these have required ligation of the jugular or subclavian veins and artery and three deaths from uncontrollable bleeding are reported.

When hemorrhage of any magnitude occurs, it is best not to attempt to grasp the blood vessel through so small an incision. The bleeding should be controlled by a tight tampon and pressure exerted by an assistant while the incision is enlarged and adequate exposure is obtained. Otherwise greater damage may be done by blind attempts at clamping vessels.

It is generally in such a situation or in a field obscured by blood that the pleura is punctured or torn, producing a pneumothorax and sometimes mediastinal emphysema.

Lacerations of the jugular and subclavian veins have resulted in four deaths from air emboli, according to reports found in foreign and American literature.

The thoracic duct is not infrequently injured; this is recognized by an immediate or subsequent escape of chyle. It can generally be controlled by the application of a snug tampon although in some instances the duct has to be ligated. In twenty cases of this accident, one death occurred three weeks after operation.

With due care, meticulous attention to minute details and orderly dissection of well defined landmarks, none of these complications should occur.

CONCLUSIONS

The technique and procedure for exposing the phrenic nerve are outlined and the numerous pitfalls that may convert this simple and minor operation into a complicated, serious and even fatal procedure are emphasized. The reasons for and the means of avoiding the errors which lead to difficulties and disaster are set forth and discussed.

A phrenic nerve crushing remains simple and safe only if each step of the operation is clearly borne in mind and the anatomic landmarks are well preserved. A large incision which leaves an unsightly scar is not necessary for adequate exposure of the phrenic nerve.

THE ROLE OF THE THYROID IN GASTROINTESTINAL DYSFUNCTION

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DURING periods of unusual economic and political adjustment there is often a coincidental increase or decrease in the number of certain types of gastrointestinal dysfunction which present themselves for diagnosis, paralleling heights and depths of crises.

This has been so consistent that it was felt that if studied comparisons were to be made, it would be found that the period during which the largest percentage of these cases was met with would parallel the low points of the Dow-Jones' averages or the low points of the various indices of business activity, and correspondingly that fewer of these cases were seen when these same indices reached high levels.

In the observation and study of such a group of cases, one is surprised to find that in only a very small percentage is true organic pathology found, and when found it is most often a duodenal ulcer.

Male patients predominate in this series of cases as they would in any similar group, although it is very possible that females, subjected to the same economic and environmental influences could form a large percentage. There is a smaller group of females, numerically speaking, comprised of wives who are conversant with their husband's business affairs, and who share intimately the economic pressure, worry, fear and apprehension and conversely the freedom from such, who enter into such a series of cases.

Analysis of the personal characteristics of the male patients demonstrates that they are predominantly of one type: the high pressure, hard driving business man, carrying an unusual load of responsibility —brokers, bond traders, speculators, the heads of larger organizations.

Crile described this particular type of individual in his treatise on hyperkinesia, calling them "hyperkinetics." He made a detailed study of the type, endeavoring to prove that they are the objects of a tremendous continuous adrenal drive, which eventually fatigues and wears itself out over a period of time. It is intriguing to speculate as to whether all business men of the hyperkinetic classification are possessed of this hyperadrenal drive as a part of their natural body makeup, or whether the acceptance of unusual business responsibility forces this drive.

In a study of such a group of cases it became necessary to ascertain the reason for the symptoms complained, ruling out, insofar as possible, the existence of any definite organic pathology.

Everyone, medically speaking, is familiar with Cannon's researches on the effect of the emotions upon the physiology of the gastrointestinal tract, particularly with regard to changes in motility and secretion, under such environmental states as worry, fear, anger, love, and hate. Determination of the "modus operandi" of these deviations from the normal physiology was necessary in order better to understand and correct the dysfunction.

Before going into the details of such a study, it would be in order to enumerate the symptoms usually complained of by these patients. They can be divided into three distinct groups, if classified according to localization of symptoms:

Group I. In which symptoms are cervical and substernal in location:

1. A substernal pressure and discomfort, usually high under the manubrium, rarely described as a pain, more often as a feeling

that something feels definitely wrong in this area.

2. "Globus hystericus"—a feeling of a lump or ball in the throat which incites constantly repeated swallowing in a more or less unsuccessful attempt to get rid of the sensation.

3. Aerophagia—a continuous swallowing of air and production of gaseous belching in an effort to produce one single satisfactory voluminous elimination of gas, giving momentary relief only, the process being immediately reproduced, so that a vicious circle is established and constant repetition takes place.

4. A sensation high in the left upper quadrant of the abdomen as of a constriction hindering the passage of food; small amounts of food seem to lodge here and not pass on; much the syndrome a patient with true cardiospasm would complain of except that the localization of symptoms is slightly lower.

Group II. In which symptoms are predominantly gastric or gastroduodenal in type:

1. A feeling of tension, of constriction, but not of actual pain in the midepigastrium.

2. Heaviness and uneasiness in the midepigastrium after a very small amount of food intake, so that the patient does not feel like eating more, although often hungry.

3. Mild nausea with resort to voluntary induction of vomiting to produce temporary relief of symptoms, then the cycle repeating itself.

4. Borborygmus and mild upper abdominal cramping pains, colicky in nature.

5. Ease and relief from symptoms if stomach is empty so that many patients are undergoing what amounts to an involuntary fasting, in order to procure freedom from distress.

6. General asthenia, loss of weight, insomnia, nervous and emotional instability. The latter subjective states are usually quite pronounced.

Group III. In which symptoms are localized in the lower abdomen and pertain to the colon.

1. Minor generalized low abdominal soreness and tenderness without spasm; shifting, cramping, colicky type of pain, mild in degree.

2. Marked intestinal flatulency with an inability to expel gas for relief.

3. A distinct change in bowel function which may be from a constipation to a series of unsatisfactory, frequent, chopped up type of movements, or the change may be from fairly normal bowel function to obstinate constipation.

4. Mental sluggishness, slow cerebration, loss of memory, headaches, dizziness, and tinnitus are quite common.

5. Insomnia, due to an inability to relax and to avoid mental concentration upon the problems in hand. In some case the low abdominal discomfort occurs most often in the early hours of the morning, interrupting and cutting short the number of hours of obtained sleep.

Such a classification summarizes all too briefly the three principal groups into which these patients may be classified from the standpoint of localization of symptoms only. It would be possible to add minor groups, occurring less frequently and consisting of those cases in which a combination or combinations of any of these three existed. Less commonly encountered is yet another group, in which detailed history taking reveals the fact that symptoms occur only during the day when the dynamic drive is on, passing off at night after the day's physical let-down, when relaxation takes place. These groups would be found rather small in actual number, and their inclusion in the main classification only obscures the issue.

Adequately to aid a group of such patients, it is necessary to peer behind the scenes, so as to speak, to get beneath the surface, and attempt a visualization of the acting mechanical forces which are interfering with normal physiology and producing the abnormal, and to ascertain in

what manner these forces are acting to accomplish this.

It is obvious that a comprehensive detailed discussion of these factors could not possibly be within the scope of a paper. For that reason only the highlights will be touched upon and these but briefly.

There exists in the body the endocrine group of glandular structures composed of the thyroid, the pituitary, the adrenal and ovary, and other less important ductless gland structures, acting either singly or in combination to produce certain definite chemical substances which we call hormones. These substances or hormones are transferred directly into the blood stream, there to perform the specific function for which they have been designated by specialization. It is vitally necessary that all of these substances shall be in certain definite ratio not only to the system as a whole, but also to one another. This is specifically true because some of these substances act synergistically. Any deviation, therefore, from the normal equilibrium in the amounts present in the blood stream or produced by the glands themselves brings about a definite change from the normal physiology.

The changes away from the normal physiology are often brought about through the action or lack of action of these hormonal substances upon the autonomic nervous system. It is by way of this complex system of nerve structure that the actual changes from the normal are brought about.

Eppinger, of Vienna, some years ago first introduced the concept of the synergistic action of the two parts of the autonomic nervous system, the sympathetic and the parasympathetic, maintaining that they must be kept in more or less constant equilibrium, and designating the deviations from this normal equilibrium as vagotonia and sympatheticotonia.

In this particular group of cases, rather consistently there is found a disturbance in the patient's emotional state, such as that produced by a sudden mental shock, by a prolonged period of worry and anxiety, or the presence of a sense of fear, sudden or continued, over a period of time, of possible impending disaster or catastrophe. This latter is usually economic and related to business. Anger or frustration, usually in the realm of love or of money, will be present in others, often with an inadaptability to reality, producing a subjective resentment and an extreme degree of emotional imbalance. These underlying emotional states are admittedly purely psychic, but the mind, influencing the entire body by way of the autonomic system, produces changes in the productive pace of the thyroid, the pituitary, the adrenal or the ovary with a resultant hormonal imbalance in body equilibrium so essential to normal physiologic function. This imbalance is specifically in the amount of hormonal production, the increase or decrease acting by way of the autonomic nervous system to produce changes in action and function of smooth muscle fiber and secretory gland activity, such as spastic contraction or atonic dilatation, with attendant stimulation or inhibition of function.

The actual mechanics involved are similar in all of the groups of cases. The anatomic site of initiation of symptoms differs in each group. Stimulation of the vagus, we know, causes spastic contraction of smooth muscle fibers. Thyroid extract fed into the blood stream in variable amounts, differing according to each individual, will cause exactly the same type of contraction. Disordered psychic states can stimulate both the vagus and the thyroid, directly or indirectly, causing temporary or intermittent over-dosages of thyroid extract, most often not sufficiently continuous as to produce a true hyperthyroidism, but sufficient to incite the syndrome of intermittent or continued pharyngeal, cardiac, and pyloric spasm, because of the contractive action of the smooth muscle in these areas. There exist two additional factors of importance: first, the majority of these patients, in order to provide themselves with an escape

mechanism, or a sort of psychic prop or crutch, take refuge in excess alcohol intake or tobacco smoking. Both of these, being definite toxic irritants to the sympathetic nervous system, thereby serve to complicate and add to the instigating or inciting factors. Secondly, women, mainly, have sought this same escape in hypnotics and sedatives, used in ever increasing dosage, a factor certainly not conducive to sympathetic system equilibrium.

Evidence has been discovered and corroborated in the experimental laboratory, that certain definite chemical substances derived from the end products of protein metabolism are liberated at the very periphery of the tiny nerve fibrils comprising the sympathetic nerve system and that these chemical substances are absorbed by the cell structures immediately adjacent, through the cell membrane into the cytoplasm, by means of an osmosis-like process, thereby influencing the function of those individual cells. The chemical product so liberated is influenced both as to amount and actual chemical composition by the state of equilibrium of the ductless gland system which, in turn, is influenced by just such disturbed states of emotion as outlined above.

A specific example of a substance so liberated is acetylcholine, which in proper amount maintains the individual body cell in protoplasmic balance, in over-amount causes dilatation and increased water retention of the individual cell. The far-reaching effects of large doses of acetylcholine on large members or groups of cells need not be gone into. Another illustrative example is the liberation into the liver and the intestine of an adrenalin-like substance termed sympathin, created by sympathetic stimulation. The effects of large doses of this product on large numbers of the smooth muscle fibers of the intestine are easily visualized. The same holds true of the liver, excessive dosage impairing normal function.

It is not to be assumed that emotional states or disturbances influence thyroid action alone. They have a direct influence upon the parathyroids, therefore indirectly upon calcium metabolism and permeability of cell membrane, upon the adrenals, therefore upon blood pressure and smooth muscle tone of vessels and capillaries, upon the ovaries, therefore upon body metabolism, thermic regulation and stability. It must be borne in mind, however, that any and every disturbance of the thyroid, regardless of how minor, does mean disturbance in the function of these other structures, or a polyglandular disarrangement. Such disturbance can be confined only to one gland, but more often secondary features are present, causing disturbances in other structures.

The immense ramification of the endocrine system and of the sympathetic is of exceptional complexity. The thyroid, however, seems to play the more outstanding rôle in all the disturbed changes which take place, and more so in the types of cases mentioned herein.

The part played by it in protein digestion, influencing the oxidation of the amino acids into urea, thereby influencing the urea content of the blood, is of no minor importance. It acts synergistically with the adrenal, influencing both proteid and carbohydrate digestion by way of sympathetic fibers to the pancreas. It has a direct influence upon the parathyroid, influencing thereby calcium balance. Its direct influence upon the pituitary regulates to a certain extent the water balance of the body. One could go on enumerating its multiple ramifications and secondary functions but space does not permit.

Disturbance of thyroid rhythm and pace, and secondarily of autonomic equilibrium, result in changes in blood hormone content, thereby affecting proteid and carbohydrate digestion. The chemical end products of such digestion are thus disturbed, both as to quantity and composition, producing changes in smooth muscle function and secretory gland activity. Specifically, they produce the pharyngeal and esophageal spasm, encountered in the cases in Group I.

The same disturbed mechanism accounts for the high substernal pressure and discomfort, the spasm of the pharyngeal and upper esophageal musculature, acting through or by way of the cervical sympathetic, to produce the "globus hystericus" and the aerophagia complained of by the patients in this group.

As to the mechanics of symptom production in the second group of cases—the musculature of the stomach being composed entirely of smooth muscle, is regulated and coördinated by the autonomic nervous system. Gastric secretion is controlled also by the autonomic, but the specific parts played by the sympathetic and parasympathetic portions is not definitely understood. It is presumed that the sympathetic exerts its action upon the chief and parietal cells of the glands of the fundus to excite the secretion of hydrochloric acid, while the parasympathetic controls the water secretion of the stomach, thereby controlling the degree of concentration of hydrochloric acid, depending upon how little or how much water is added to it.

With sympathetic irritation there is a tendency for dilatation of smooth muscle, so that an atonic, dilated stomach with a wide open patent pylorus is encountered, food passing almost immediately from the stomach into the intestine, which is ill-fitted physiologically to carry on the first stages of digestion. With sympathetic stimulation the adrenal influence upon the pancreas is also affected so that a resultant depression of pancreatic function takes place, serving to aggravate the problem of food digestion by impairment of the rôle played by the upper part of the small intestine.

Alvarez recently pointed out that in impairment of digestive function the small intestine had a great share, particularly with reference to the production of gastric symptoms.

The opposite picture from that produced by sympathetic irritation can also take place in the stomach: spasm or contraction of the smooth muscle, most often in the region of the pylorus, due to stimulation of the parasympathetic. Which one of the two systems, sympathetic or parasympathetic, obtains the ascendency in control may vary, depending entirely upon the physico-biologic makeup of the individual, and the influence of his environmental and emotional state. Both may be irritated simultaneously, producing even greater disturbance in equilibrium, greater imbalance, greater disorganization.

With a contracted spastic stomach musculature and a pylorospasm, the syndrome of feeling full and distressed after a small amount of food intake is accounted for, as is also the duodenal type of symptom syndrome encountered in this Group II of cases.

The mechanism involved in production of symptoms in Group III is identical except that a lower anatomic division of the autonomic is involved, exerting its influence upon a lower anatomic segment of the gastrointestinal tract.

The site of action of these sympathetic impulses depends upon whether they originate in or about the cervical, celiac or splanchnic plexi, or lower still in the superior or inferior mesenteric or hypogastric plexi.

The intimate relationship between the emotions and the gastrointestinal function has long been an established clinical fact. Everyone knows from personal experience that agreeable, pleasurable emotions are conducive to a better state of digestion and intestinal function and that disagreeable emotions produce the contrary. Pavlov, Cannon, and Ivy have described instances of complete inhibition of gastrointestinal motility and of glandular secreting activity as the result of emotion. In more recent years these same men have been confirming how and by what actual physical means these changes take place.

Usually the gastrointestinal reaction to an emotion exists only for as long as the original incitor persists, subsiding when the emotion ceases or changes. The indi-

vidual possessed of a stable, well developed nervous system kept under control, is able in a large measure to throw off or suppress any expression of emotion. His visceral response to emotion may be intense, but only momentary, returning immediately to normal physiologic balance. An unstable individual, or one who has been made so by long continued conflict with emotions, particularly if this conflict is unsuccessful, does not snap back to the physiologic normal so quickly; there is either a time delay in his reversal or no return at all to the normal.

The first individual possesses what we choose to call "physiologic adaptation." Even in such an individual, however, continued irritation by a disagreeable emotion over a period of time can affect his power of adjustment, the time interval required for snapping back to normal becoming increasingly prolonged up to a hypothetical point of complete exhaustion of this power.

The more frequent and more severe the emotional upset, the more the ability of the individual to "take it" becomes impaired. The next time it will make a greater impression upon him, and each time his resistance to it is lessened, because the underlying factors, the thyroid, adrenal, pituitary, carrying the load, become impaired in their capacity to respond, through sheer fatigue from overwork.

It is in such manner that the symptoms of these three groups of cases have been brought about by:

First: Impaired physiologic response to emotional stimuli.

Second: Disorganization of the equilibrium of the autonomic nervous system, the sympathetic or the parasympathetic being in command, depending upon the physicobiologic makeup of the individual, influenced by his environmental and emotional state.

Third: Direct action upon the endocrine system, mainly through the thyroid and adrenal.

Fourth: Deviation from the normal in the function of the smooth muscle structure and the glandular secreting activity of the stomach and pancreas takes place, producing the symptom syndromes complained of, depending upon which anatomic group of sympathetic plexi impulses originate at.

DISCUSSION

Considerable confusion and lack of recognition exists as to these groups of patients. Of prime importance is to rule out, by means of intensive search, any organic pathology. It must be kept constantly in mind that the possibility exists of the supposedly functional being so prominent as to mask the existence of an actual organic lesion.

Because of the psychic makeup of the individuals composing these groups there exist exceptional opportunities for introspection and self-analysis, which are, more often than not, detrimental to the individual. This introspection can be of such degree as to cause a disorganization of the personality and even a psychosis. One must differentiate this group and not confuse it with the groups outlined here. These cases are more in the realm of psychopathology. In some few of these latter, laboratory procedures may be of help in differentiation. Willful invalidism, malingering, symptoms of an escape mechanism from daily problems, serve only to test the physician's observation and diagnostic acumen.

It will be found in these groups that very often there exist associated ailments not directly referable to the chief complaint, but indicative rather of the low state of body metabolism and resistance, for example, an associated sinusitis, neuritis, arthritis, migraine, or phlebitis.

Objective and laboratory procedures may be of some help or none at all.

Blood pressure readings are important in discovering a true hypotension or a clue to a true adrenal insufficiency.

Complete blood examination, including cell count and differential, may uncover an underlying secondary or primary anemia

which would have to be corrected in the course of bringing the patient to normal equilibrium.

Basal metabolic determination is important, as a large group of these individuals tend toward a hypothyroid state. When one is faced with distinguishing between true hypothyroidism, a blood cholesterol determination is of value, invariably being raised in the true hypothyroid.

Gastric analysis will in some cases reveal a low concentration of free HCl or even a definite achylia, in others the exact opposite. The mechanism of HCl production and its deviations in these cases has been discussed.

Roentgenologic examination of the gastrointestinal tract, more particularly fluoroscopic examination, will reveal the state of muscle tone of the stomach itself, the patency or spasticity of the pyloric sphincter, the degree of intensity and frequency of peristaltic activity present, and much additional information of value.

Some of these cases present certain aspects of hyperthyroid activity, others of hypothyroid, others of a hypoadrenalin function. Each such type must be differentiated in order to institute successful therapy. Pavlov's conception of life is most adaptable in explanation of this group of cases, because they represent those who temporarily are disintegrated. He maintained that man in his normal state represented a beautifully integrated, harmoniously acting, complex mechanism, indicating physiologic equilibrium. Brown-Sequard gave to this idealistic state a term, "Le milieu interieur"—or that state of the body when all of the hormones, all of the electrolytic ions, the vitamins, the enzymes and the products of anabolism and catabolism exist in their proper proportion and proper relationship.

How complex this thing we call life is. As medical men we all are concerned with deviations from this ideal state, and with the restoration of the individual to the closest possible approach to this state. It is with such a thought in mind that attention is called to this group of cases that they may be the recipients of more studious and intelligent effort, and not be classed indiscriminately as neurotics.

THERAPY

It is obvious that to treat visceral manifestation of emotional and environmental stress without attempting to remove the cause would be futile. Therefore in therapy must be considered an abrupt severance of proximinal influence.

Environmental Change. For various reasons environmental change is most desirable. It immediately removes the individual from the source of his irritation. Distance tends to diminish the intensity of situations. What seemed unsurmountable and mountainous because of its very propinquity does not seem so terrifying from farther away. Sober evaluation takes place, fear and uneasiness diminish or are banished completely.

Psychotherapy. The therapeutics of the mind offers an opportunity for the institution of measures tending to restore functional balance and normal emotional equilibrium. The physician by a rational explanation of the actual physical factors involved in the production of symptoms may be able to banish apprehension and fear on the part of the patient. Better coöperation results and a faster return to normal. This is the more easily applicable to the patient possessed of a sufficiently understanding intelligence.

Instruction may provide an adaptation to problems, psychic adjustment, may aid the disciplining of the emotions. Patients fear that which they do not know; given a rational explanation, fear is banished and the first step in the restorative comeback produced.

Restoration of Physiologic Balance. It is here that selectivity must be employed by the physician. If the overactive thyroid dominates the picture then measures should be instituted to reduce and regulate thyroid activity.

If the opposite is present and a hypothyroid state, subclinical or true, as manifested by hypotension, asthenia, constipation, etc., is present, then measures for its correction are in order. Substitution glandular therapy is often productive of amazing results.

It is surprising how many patients will be found in this group. They have been on many and varied gastrointestinal regimes without success, but respond when the underlying factor is corrected.

In the group presenting the syndrome of underactivity of the adrenal, where there is a mild subclinical hypoadrenalinism or even a true deficiency, the response to adrenal cortex therapy is encouraging.

In the hypo-ovarian group the response to endocrine therapy is more than encouraging.

As mentioned previously, an underlying anemia, a focus of infection, any attendant ailment, must be adequately taken care of.

The effect of these deviations from normal in endocrine and sympathetic function upon the hydrogen ion concentration of the blood and of the acid-base equilibrium have been purposely omitted here.

Much in this endocrine and sympathetic system field is as yet unknown to us, but the great advances being made in the knowledge of the human body's response to environmental influence will in the coming years help us to solve these problems all the more successfully.

A METHOD FOR REGULATING PRESSURE IN THE COMMON DUCT FOLLOWING CHOLEDOCHOSTOMY*

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THE importance of the regulation of pressure in the common duct following choledochostomy has been emphasized by many authors.[1,2,3] Ravdin and Frazier[4] state that intense hyperemia with extravasation of blood into the liver tissue follows sudden release of tension. These authors point out that the maintenance of pressure on the common duct drainage tube forces part of the bile into the duodenum with resultant improvement in appetite and general well being. Despite the fact that bile draining from a liver damaged by common duct obstruction is deficient in bile acid,[5,6,7,8] it is of some advantage to conserve the bile as much as possible. The entrance of bile into the intestine avoids the necessity of instilling bile into the stomach through a tube which, at best, is bothersome and unpleasant to the patient. Furthermore, a saving of fluids and electrolytes is effected, which is a factor to be reckoned with when there is prolonged drainage of bile to the exterior.

Ordinary tube drainage into a bottle on the floor results in actual siphonage of bile from the common duct. Ravdin and Frazier avoid this by interposing a Y-tube, which is hung at any desired level at the bedside. Reid in 1921 stressed the importance of maintaining pressure on the drainage tube from the common duct and described a simple method for accomplishing this which is similar to that presented in this paper. We have found this method not only effective for maintaining pressure on the common ducts but advantageous in that it permits sterile collection and measurement of bile. We have found that the intravenous bottles and dispensing caps supplied with commercially prepared intravenous solutions supply the needed equipment. Since many hospitals purchase intravenous solutions, these are usually available. All that is necessary is that a sterile bottle with an inlet tube and suitable vent be available. The collecting bottle may be placed at varying heights above the level of the common duct to regulate the pressure against which the bile must flow.

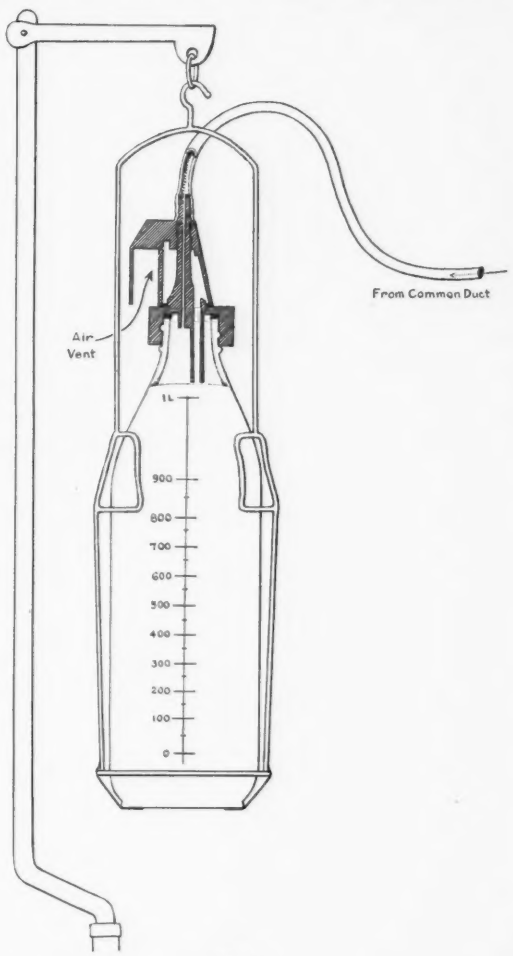

FIG. 1.

DIAGRAM

The common duct tube is kept clamped until the patient is returned to bed. The

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tube is then attached to the intravenous set described above. The bottle is fitted into a wire basket, bottom down, and hung on an intravenous stand at the bedside. The level of the bottle can be regulated as desired on the intravenous stand.

The greatest advantage of this method is that no special apparatus is required. Clean, sterile intravenous sets are usually available. The bottles are frequently graduated so that the amount of drainage for any given period can be determined with ease, and the untidiness and odor associated with draining bile into open bottles on the floor is avoided. The height of the bottle in relation to the level of the common duct is easily adjustable and bile drainage can be obtained under sterile conditions. Samples can easily be obtained by exchanging bottles. Immediately postoperatively the bottle is hung a few centimeters above the level of the common duct and is then varied from day to day, depending on the amount and character of the drainage and the patient's condition.

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THE COMPARATIVE RESULTS OF PARTIAL EXCISION OF THE PANCREAS WITH THE SCALPEL, ACTUAL CAUTERY AND ELECTRICAL HIGH FREQUENCY KNIFE*

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IN 1934, Dr. George Thomason,[1] in writing on the removal of a portion of the pancreas, stressed the point that "to cut this organ with the cold knife is an unfortunate surgical error."

To determine, if possible, the advantages

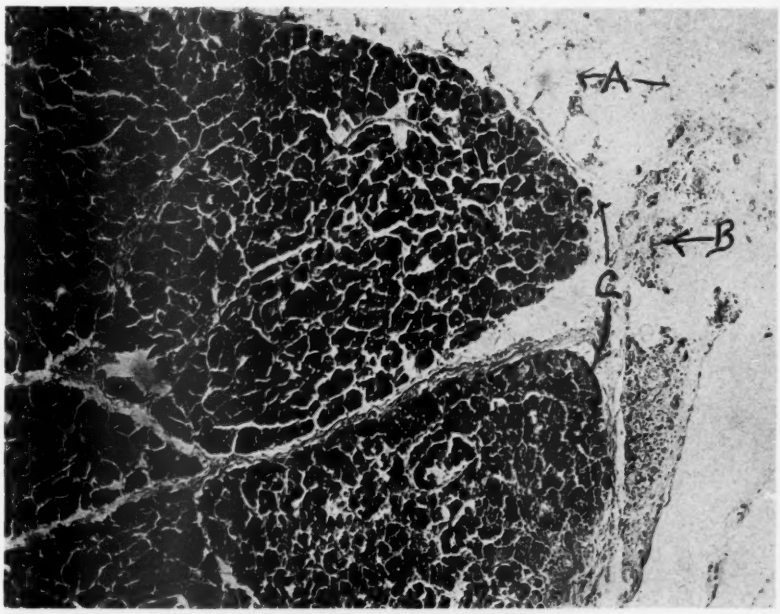

FIG. 1. Dog 1. Operation A. G.E. high frequency knife. Healed pancreas stump thirty-three days postoperative. A, loosely adherent omentum. B, connective tissue stroma. C, healed end of pancreas gland, conical shape, normal cells.

there is considerable advantage in the method of excision by means of the Percy cautery. Dr. Percy, in his discussion of this article, emphasized the value of actual cautery resection of the pancreas in overcoming the usually immediate hemorrhage as well as postoperative infection, both of which are possible when using the plain knife. He also points to another great advantage in the use of the cautery, namely, the prevention of postoperative pancreatic secretion from flooding the field. He states

[1] *Tr. West. Surg. A.*, p. 85, 1934.

or drawbacks of the respective methods was the aim of our experiments. Any advantage due to control of bleeding during the progress of the operation we have not considered because in the dog the blood vessels are so few and easily controlled by any method used that in our opinion it was not a point worth stressing.

We used dogs as subjects because the dog's pancreas is horseshoe-shaped with one rather long limb along the stomach, and the shorter distal limb along the duodenum, the main duct entering the

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duodenum near the convexity or apex of the U-shaped gland. The head portion has a fairly loose attachment along the distal part of the duodenum, and easily lends itself to a single or to several excisions. In order to overcome any possible pathologic or physiologic reaction of an individual animal to any one method, we used all three successive methods in animals 1 and 4. Regardless of the method used, the scars of the second and third excisions on the same pancreas had slightly more

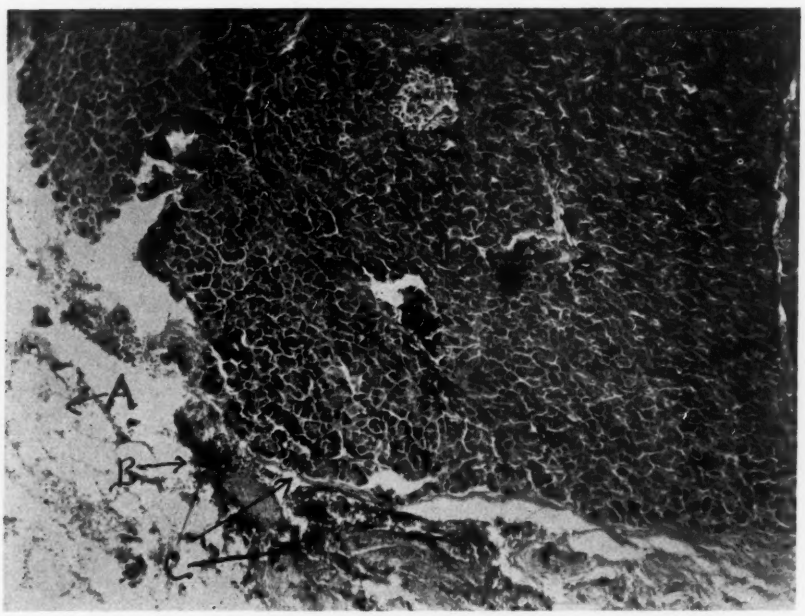

FIG. 2. Dog 1. Operation B. Actual cautery excision. Healed pancreas stump fifty-eight days postoperative. A, adherent omentum over stump end with excess fat. B, excess fibrous connective tissue. C, healed end of pancreas with islands of normal pancreatic tissue in the scar.

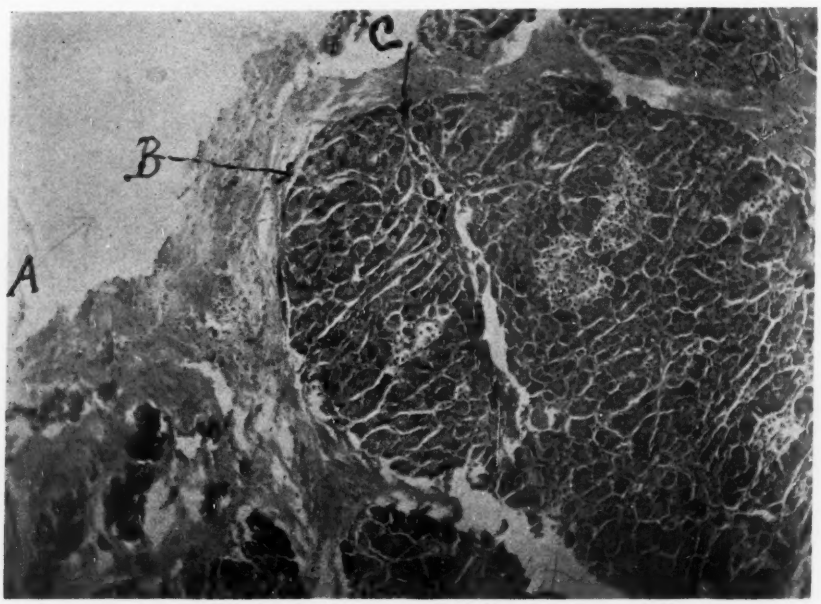

FIG. 3. Dog 1. Operation C. Scalpel scar. Healed pancreas stump eight months postoperative. A, fat containing leucocytes. B, fibrous connective tissue stroma. C, healed end of pancreas gland, normal ducts, slightly swollen island tissue cells.

adhesions about the stump than did the first excision.

The same technique of operating was used in all the dogs. The animal was given a preliminary dose of morphine sulfate, 1 c.c. of 2 per cent solution per kilo of body weight, one hour before operation. Ether was then given on the open mask to the point of complete anesthesia and then an intratracheal tube was used. On dogs 1 and

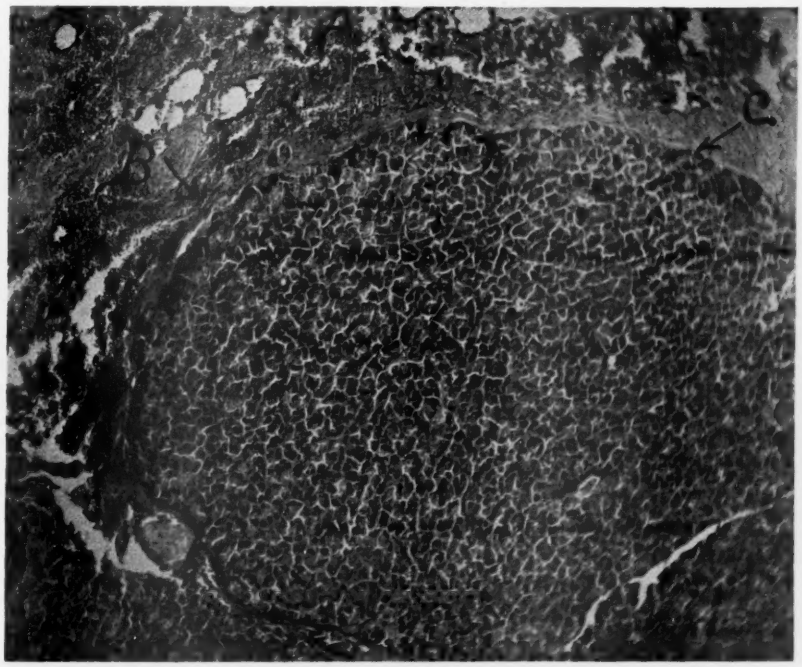

Fig. 4. Dog, IV. Operation B. Actual cautery. Healed pancreas stump twenty-eight days postoperative. A, well healed omentum. B, uniform fibrous connective tissue stroma. C, smooth rounded end of pancreas gland.

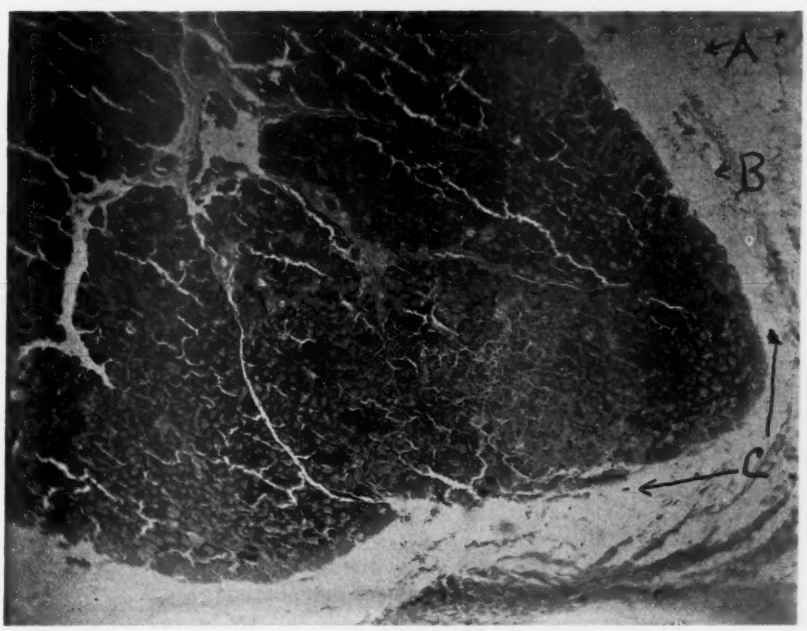

Fig. 5. Dog V. Operation A. Scalpel scar. Healed pancreas stump two months postoperative. A, omentum. B, thin fibrous tissue covering of stump. C, healed end of pancreas gland, conical shape, with normal cells.

Dog No.	Weight in Kilo	Operation No.	Date	Method	Date Examined	Pathologic Report	Gross Appearance
1	12	1	1/15/35	G.E. electrical knife	2/28/35	The stump end is covered with fat. No scarring. The pancreas and ducts appear normal.	Omentum loosely adherent to stump. No other adhesions.
1	12	2	2/28/35	Actual cautery	4/27/35	There is an increase of fat and fibrous tissue over the cut end. There are some islands of pancreatic tissue in scar which look normal.	Omentum firm on stump end. Some adhesions about operative field.
1	12	3	4/27/35	Scalpel	12/17/35	Surface of stump covered with fat and fibrous tissue. Few leucocytes in fat. There is a definite increase in the lobules of the pancreas. Island tissue very abundant. Cells rather swollen. Ducts appear normal. Not much inflammatory reaction about the sutures in this specimen.	There were moderate adhesions about the stump, but none elsewhere and no evidence of other tissue degeneration.
2	..	1	12/22/34	Cautery	3/2/35	.....	Omentum over stump moderately adherent. Only a few adjacent adhesions.
2	..	2	3/2/35	Scalpel	3/5/35	Early healing over stump. Some evidence of early infection. Many pancreatic cells over free border are undergoing necrosis.	Dog chewed wound open. Numerous fibrinous adhesions. No pus. Specimen several hours post-mortem.
3	10	1	2/19/35	Cautery	4/20/35	In the end of the stump are some degenerative changes in the pancreatic tissue covered by the usual amount of fat and connective tissue.	Omentum firmly adherent to stump end with moderate adjacent fibrous adhesions.
3	10	2	4/20/35	Scalpel	.....	.....	Moderately firm omental adhesions over stump. No adhesions to intestine.
4	7	1	12/15/34	Scalpel	3/30/35	Stump is covered by thin layer of fibrous tissue. No fat. Pancreas at edge is normal. Islands, tissue and ducts are well preserved.	Very slight attachment of omentum to stump. No other adhesions.
4	7	2	3/30/35	Cautery	4/27/35	The end of the pancreas is covered with fat and connective tissue. There are several areas of inflammation about the ligatures. There is some interlobular increase of connective tissue. The pancreas tissue looks normal.	Slightly firmer, many and more omental adhesions over stump than at operation.
4	7	3	4/27/35	Electrical knife	8/4/35	.....	Omentum loosely adherent to duodenum at operation site. Pancreas atrophic.

Dog No.	Weight in Kilo	Operation No.	Date	Method	Date Examined	Pathologic Report	Gross Appearance
5	..	1	2/5/35	Scalpel	4/6/35	Inflammatory reaction about ligatures with considerable scarring about stump. Pancreatic ducts and islands are normal.	Very few omental adhesions to stump.
5	..	2	4/6/35	Cautery	8/4/35	.....	Very slight amount of fibrous adhesions about stump. Smooth.
6	7	1	6/1/35	Electrical knife	10/6/35	Stump normal in healing. Not much fat and fibrous tissue. Pancreatic tissue normal.	Good smooth scar over stump with slight omental adhesions.
7	6½	1	6/1/35	Electrical knife	8/18/35	Developed mange.	Usual smooth flattened conical end with few omental adhesions to stump end.

4 three operations were performed; on dogs 2, 3, 5, 6 and 7 two operations were performed.

At each operation the abdomen was opened by an upper midline incision. The head end of the pancreas was found, brought out and 1 cm. of the tip removed at right angles to the long axis of the pancreas either by (1) scalpel, (2) actual cautery, or (3) by electrosurgical knife (high frequency). Bleeding points were then clamped and ligated with cotton thread. The pancreatic duct was never sought and never intentionally ligated. The stump was cut squarely across in every case. A bit of omentum was then sutured over the raw end with fine silk. The abdomen was sutured, the earlier cases with No. 2 twenty day catgut, and the later with fine silk or cotton thread and the wound covered with collodion.

The second and third operations were performed in the same way on the same animal after three to six weeks had elapsed. At each second or third operation the condition of the general cavity was examined for peritonitis, fat necrosis, presence of fluid or adhesions and findings were noted.

At the second and third operations about 1 to 2 cm. of the previously cut end of pancreas with the omentum covering it were then cut away from the head end, so that blocks and sections could be made to show the microscopic appearance of the excision line.

Another segment 1 cm. long was removed by a different method from that previously used. The vessels were ligated, the stump was covered and the wound closed exactly as before.

Again after three to six weeks, the animal was operated upon and the observations made as at the second operation. If a third operation was done it was performed in a similar manner, making a total of about 3 cm. of pancreas removed from the head end. After three to six weeks the abdomen was again opened and examined as before, and the terminal centimeter of stump with omentum covering it was removed for microscopic study.

Without exception in the cases examined after three weeks or longer the stump had assumed the shape of a wedge with convex edge like the normal pancreas end, and no longer remained as a blunt, squarely-cut stump as left at operation.

All microscopic examinations were made in the Pathology Laboratory of the St. Louis University School of Medicine and reported by Dr. J. R. Roberts, Associate

Professor of Pathology, to whom we wish here to express our grateful thanks. The specimens were fixed in 10 per cent formalin solution. They probably showed less cell detail than if Zenker solution had been used. All sections were cut in the same relative plane, in the long axis of the pancreas (parallel with and as near as possible to its central duct) and in the shortest diameter of the ellipse shaped cross section of the dog's pancreas. Table 1 gives a detailed summary of the experiments. It will be noted that there is but little difference in the gross and microscopic picture after operation 1, regardless of the method of cutting used. On gross examination the only difference noted after operations 2 and 3 was that there were rather more adhesions about the stump and relatively more pancreatic tissue after the third section as the gland is normally thicker there.

CONCLUSIONS

There is least bleeding after excision by cautery and less after excision by electrosurgical high frequency surgical knife than after excision by scalpel, but even after scalpel excision the bleeding is not a problem worth considering. Our observations never revealed any evidence of postoperative peritonitis, collection of pancreatic secretion or fat necrosis. The distal end of the pancreas heals equally well if covered by a bit of omentum, regardless of whether it is excised by the scalpel, actual cautery or electric high frequency knife.

THE ROLE OF SPLENECTOMY IN DISORDERS OF THE SPLEEN

REPORT OF A SERIES OF THIRTY-THREE COLLECTED CASES

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SPLENECTOMY was first performed by Fioravanti in 1549, and the first substantial series of cases (fifty-three) was reported by Adelmann in 1887. During this era, wounds, abscesses, cysts, torsion of the pedicle, and enlargement due to malaria made up the list of disorders for which the organ was removed. Today, the aforementioned causes are of infrequent importance, and certain blood dyscrasias now lead the list of indications for splenectomy. These blood disturbances are collectively designated as the splenic anemias. Those which will command our attention are (1) chronic hemolytic anemia, (2) Banti's disease, (3) idiopathic purpura hemorrhagica, and (4) Gaucher's disease. Their progress leads to one or both of the following complications which may frequently overshadow the splenomegaly in the symptoms and signs they exhibit: (1) liver damage with jaundice and ascites; and (2) a chronic anemia which is either hemorrhagic or hemolytic in origin. The spleen is also removed for rupture of the organ and enlargement due to tumors, cysts, and, at times, syphilis and malaria.

Chronic hemolytic anemia was first described by Minkowski in 1900. Splenectomy produces dramatic results in this condition. The diagnosis rests on increased fragility of the red blood cells, reticulocytosis, increased excretion of urobilinogen in the urine, and icterus. Curiously enough, 60 per cent of these patients have gallstones. The anemia is progressive, but then is followed by disappearance of both jaundice and anemia, although the microcytosis and fragility of the cells remain. Frequently after splenectomy, the platelets rise to unusual heights and there is danger of mesenteric or portal thrombosis with high fever, abdominal pain, and convulsions. This may subside spontaneously after a few days when the platelet count returns to normal. If severe, deep Roentgen therapy should be applied before thrombosis appears.

Banti's disease is characterized by a progressive anemia with splenomegaly, leucopenia and thrombocytopenia. This same triad may be produced by certain acute and chronic infections, hemolytic anemia, Cooley's disease, leucemia, hepatic cirrhosis, and lymphoblastoma, and must be ruled out. As the disease progresses, hepatic cirrhosis with jaundice and ascites appears. Gastric and esophageal hemorrhages are quite common due to the subsequent engorgement of blood in the portal circulation. The prognosis depends then upon the amount of cirrhosis found at operation. Even in the late stages of the disease, splenectomy is quite justified on two scores: (1) the amount of blood in the portal circulation is reduced some 20 to 25 per cent, exerting a reduction of load on the scarred liver, and (2) the reduction of portal congestion obviates frequent gastrointestinal hemorrhages and resultant anemia. The liver in these cases has marked regenerative power. If the ascites is marked, one may perform an omentopexy in addition; and for repeated esophageal hemorrhage, coronary ligation is of definite value. If we are to accept Brandenburg's and Eppinger's conception that Banti's disease is not a separate clinical entity but merely a splenomegalic form of hepatic cirrhosis, we turn to the fact that W. J. Mayo performed splenectomy in some nineteen cases of true primary cirrhosis in

the last stages of the disease with good results. Present day management of cirrhosis permits more flexible medical treatment, while the ascites is handled surgically. The risk of splenectomy in Banti's may be somewhat greater than in the other splenomegalies due to the intimate nature of adhesions between the spleen and the diaphragm.

We caution against the advocation of splenectomy in another disease entity which resembles Banti's. This is a splenomegaly with gastric hemorrhage but the splenic enlargement follows the hemorrhage within a day or two. These patients exhibit a portal thrombophlebitis quite commonly, and the spleen is thought to enlarge due to the stasis. Omentopexy and coronary ligation may be of considerable aid, but splenectomy gives deplorable results.

In purpura hemorrhagica idiopathica we have a comparatively rare disease, although symptomatic purpura is common, particularly in children. This disease was first described by Werlhof in 1735. About 80 per cent of those afflicted are females who have prolonged menses. There is a secondary anemia with a reduction of platelets. Subcutaneous and gastrointestinal hemorrhages are common; there is a prolonged bleeding time, delayed clot retractility, positive tourniquet test, and a normal coagulation time. Medical treatment is advisable in the acute phase of the disease as remissions are quite common. The only reluctance in delaying splenectomy is the frequency of intracranial hemorrhages following trivial trauma in these youngsters, when removal of the organ might have afforded a cure. After removal of the spleen the platelets rise to normal within the first week or so but do not remain there; however, hemorrhages are never so common or so severe as before splenectomy. Whipple reported seven deaths in eight operations performed during the acute phase, while there were only six deaths in seventy-three cases operated on during the chronic stage.

In Gaucher's disease we have a familial entity characterized by hemochromatosis, hypochromic anemia, leucopenia, thrombocytopenia and a later osteomalacia of bones with pathologic fractures. The spleen enlarges to great dimensions and there is deposition of kerasin in the whole reticuloendothelial system. Biopsy of the spleen or bone marrow reveals a characteristic lipoid laden pulp. Splenectomy is performed for symptoms produced by its enlargement, viz., pressure symptoms, severe anemia, or retardation of growth of the child.

Tumors and cysts of the spleen are relatively uncommon. Splenectomy is performed when exploration reveals their identity. One must remember that polycystic disease of the spleen may be associated with polycystic disease elsewhere.

Trauma is again becoming more important with the increase in auto accidents. Intraperitoneal hemorrhage with the history of a blow over the spleen should render suspicion of a rupture of the viscus. Splenectomy should be performed within the first twenty-four hours, as expectant treatment during this interval produces a 90 per cent mortality.

We have collected a series of thirty-three splenectomies performed in southeast Texas during the last ten years. In this group two were removed for hemolytic anemia with no deaths; ten for Banti's disease with three deaths; eight for purpura with four deaths; two for malaria with one death; three for leucemia with three deaths; one for lymphosarcoma of the spleen, and one incidentally to facilitate removal of a carcinoma of the stomach; and six for rupture of the spleen, with three deaths. (Table 1.) One patient with Banti's disease lived eight months, then succumbed from hepatic cirrhosis. One of the authors' cases of Banti's with grade 4 cirrhosis who was subjected to splenectomy with amentopexy has an apparent cure after four years. Another of our personal cases of Banti's gave a dramatic response to splenectomy and coronary ligation after multiple severe esophageal hemorrhages. We no longer

advocate removal of the spleen in the leucemias, as in doing so we would be removing the burial ground for the white cells which are already abnormally high.

Table 1

Splenectomies	No.	Died
Chronic hemolytic anemia	2	0
Banti's disease	10	3
Purpura, idiopathic	8	4
Malaria	2	1
Ruptured spleen	6	3
Leucemia	3	3
Lymphosarcoma	1	0
Incidental to gastric resection	1	0
Total	33	14 (42.4%)

The total operative mortality of this group was 42.4 per cent which we think much too high. Splenectomy should carry a surgical risk of less than 10 per cent even in far advanced lesions.

CONCLUSIONS

1. Splenectomy is indicated in the treatment of the various splenic anemias, for trauma, cysts, tumors, abscesses, torsion of the pedicle, and at times in syphilis and malaria.

2. Omentopexy and coronary ligation are to be performed in addition to splenectomy for the complications of the splenic anemias, viz., ascites and gastrointestinal hemorrhage.

3. A series of thirty-three collected cases is reported herein, exemplifying the indications for splenectomy. The combined operative mortality was 42.4 per cent.

4. The surgical risk of splenectomy even in late stages of disease should be less than 10 per cent.

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THE TREATMENT OF ENDOCERVICITIS WITH CARBON DIOXIDE SNOW (DRY ICE)*

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ENDOCERVICITIS is one of the ailments which stubbornly resists medical treatment. The methods of therapy are legion. They may be classified as:

1. Biological: introduction of cultures of Doederlein bacilli into the vagina.
2. Chemical:
   (*a*) Topical application of antiseptics in liquid, powder or paste form.
   (*b*) Injection of chemical solutions under the cervical mucosa.
3. Thermal: Paquelin cautery.
4. Electrical:
   (*a*) Nasal tip cautery.
   (*b*) Coagulation.
   (*c*) Conization.
   (*d*) Ionization (copper, zinc, mercury).
5. Radium.
6. Surgical: Sturmdorf operation.

It is generally accepted that to cure endocervicitis one must destroy the diseased glands of the cervix. To achieve this it is necessary to sacrifice some of the surrounding tissues. One may easily accomplish this with any of the electrical methods. However, untoward sequelae may result:

1. Bleeding:
   (*a*) Immediate—at the time of the procedure.
   (*b*) Delayed—when the necrotized tissue sloughs.
2. Infection.
3. Cicatrization—causing stenosis or even complete atresia of the cervical canal with consequent sterility, cervical dystocia, hematometra and pyometra.

These unsatisfactory results not only militated against the indiscriminate use of the electrical methods but also prompted the search for a new necrotizing agent which would possibly avoid them. Such an agent belonging to the thermal group was found in the compressed form of carbon dioxide snow, popularly known as "dry ice."

Dry ice has a temperature of 109 degrees below zero. It is a dense, snow-like substance which evaporates to a dry gas.

Carbon dioxide snow as a therapeutic agent in medicine is not new. It was extensively used during the first decade of this century in various skin and eye diseases. Recently its use has been considerably curtailed due to the introduction and advancement of the various electrical methods. The destructive action of dry ice is ascribed to the rapid freezing and thawing of the treated areas. The cells rupture by expansion. The depth of necrosis is dependent upon the time of application and the pressure used. The cicatrization of the treated areas is minimal. It has been demonstrated that the epithelial cells are more sensitive to freezing than the connective tissue cells. This reaction resembles that of radium.

The following routine was worked out for the treatment of endocervicitis with dry ice.

The patient is placed in lithotomy position. A bivalve speculum is inserted into the vagina and the portio vaginalis is made visible and accessible. The vagina is wiped dry with cotton balls, the cervical canal with cotton applicators. No antiseptics and no anesthesia are used. The cervix is inspected and measured. An ice rod, long

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and large enough to fill the cervical canal is cut from the ice brick. It will be found easy to cut the ice rod into the desired shape if a large kitchen knife, dipped from time to time into hot water, is used. The ice rod is grasped with a uterine dressing forceps at its widest end and introduced into the cervical canal as far as the internal os. Considerable pressure should be used during the application of the ice. As soon as the ice touches the cervix, the seething sound of the rapidly vaporizing ice will be audible and a dense gray gas will fill the vagina. This gas may be blown away and the actual freezing of the cervical tissue observed. In twenty or thirty seconds a white ring of natural ice will surround the dry ice stick. The seething sound ceases after fifty to sixty seconds and this indicates the end of the treatment. The dry ice may then be removed. By keeping the ice in the cervical canal for an additional ten to thirty seconds a prolonged treatment may be rendered. After withdrawal of the dry ice rod the natural ice will be visible in the cervical canal for about one minute. When the frozen area in the cervical canal melts the cervix will reappear in its former color and shape. Slight hemorrhage will fill the cervical canal. This bleeding is an indication that the treatment has reached the proper depth. If no bleeding occurs, the procedure should be repeated immediately. Before reintroducing the dry ice the cervical canal should again be wiped dry with cotton applicators. If an erosion is present, the dry-ice should be pressed against the eroded area. Treatment should not be repeated more often than once in four weeks. The freezing of the dry ice acts as an anesthetic agent and the patient as a rule experiences no pain during the treatment.

The after treatment consists of inspection of the cervical canal once or twice a week at which time tincture of iodine may be applied to the treated areas. The patient is instructed to douche with hot alkaline solution (two tablespoonfuls of bicarbonate of soda to two quarts of hot water) whenever necessary for cleansing purposes.

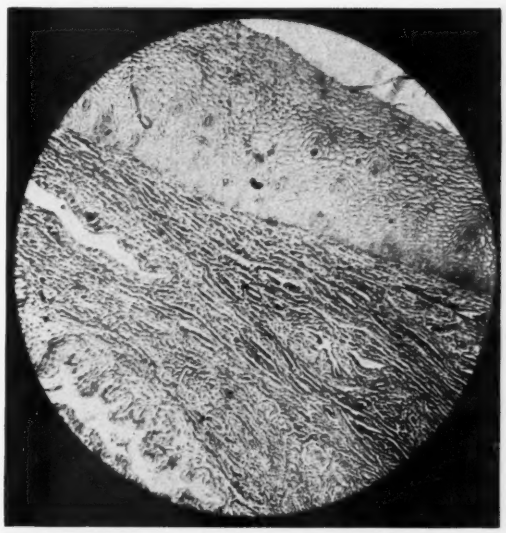

Fig. 1. Biopsy taken twenty-four hours after treatment.

PRECAUTIONS

1. Do not handle the ice with bare hands. Burns may result. Always use a towel.

2. In cutting the ice with the knife, use a long sawing motion without pressure, as otherwise the ice will crack.

3. Use warm water for warming the knife; do not use a flame.

4. Do not touch the vulva or vagina with ice or the uterine forceps holding it, as this will cause pain.

5. It is unnecessary to use a tenaculum on the cervix.

6. If the ice breaks in the cervical canal do not try to remove it but allow it to melt in the canal.

7. Use considerable pressure! This is very important.

8. Tampons are unnecessary.

POSTOPERATIVE COURSE

The leucorrhea stops completely for twenty-four hours, following which it reappears, becomes milky and later watery in character. Seven to ten days after treatment the amount of discharge slowly dimin-

ishes. Normal cervicovaginal discharge with normal anatomic findings is observed in five to eight weeks. At this time the subjective symptoms disappear and the cure is complete.

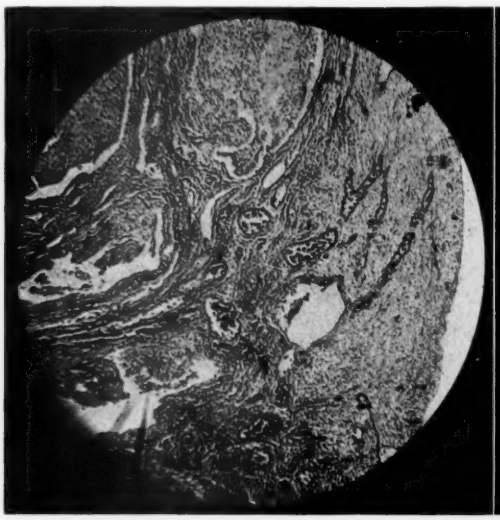

Fig. 2. Biopsy taken seven days after treatment.

Fig. 3. Biopsy taken sixteen days after treatment.

CONTRAINDICATIONS

1. Microscopically proved malignancy of the cervix.
2. Acute external gonorrhea with predominant urinary symptoms.
3. Pelvic infections in the acute stage.
4. Pregnancy.

Palpable chronic adnexal masses were not considered as contraindications to the treatment.

PATHOLOGY

Inspection of the treated areas twenty-four hours after treatment shows them to be covered by a grayish pseudomembrane. This membrane is easily removable and consists of tissue débris mixed with mucus and pus cells. Under this membrane the red raw surface of the cervix is visible. The microscopic picture shows an extensive destruction of the cervical mucosa. (Fig. 1.) Seven days after treatment the areas are no longer covered by a pseudomembrane. The cervix bleeds readily to touch. Biopsies taken at this stage show areas of necrosis still present, but in general the picture is one of early regeneration, especially in the region of the stratified squamous epithelium. A conspicuous feature of the microscopic picture is the almost total absence of inflammatory changes. There is a moderate round cell infiltration; few plasma cells and a few leucocytes are present. (Fig. 2.) Ten to seventeen days after treatment macroscopic signs of healing are visible. Finger and v-shaped incursions into the areas of the erosion appear and the visible portion of the endocervix has the appearance of a granulating wound. Biopsy at this time shows a picture of active regeneration. The squamous epithelium is broadened, the stratum germinativum is wide, the nuclei are deeply stained. (Fig. 3.) Three to four weeks after treatment the entire area of the erosion is covered by stratified epithelium which has a marmorated appearance. Pale areas are surrounded by thin dark red lines. These lines disappear during the fifth or sixth week. The microscopic picture at this time reveals an increased activity of the stratified squamous epithelium. The stratum germinativum is still broad and the stratum corneum shows extensive vacuolization. The erosion appears in second stage healing. (Fig. 4.) Eight weeks after treatment cervical biopsy shows complete cure. (Fig. 5.)

During the microscopic study a very important finding was noted. In thirty-one cases out of 111 (30 per cent), atypical cells were found in atypical arrangement, apparently invading the surrounding tissue. These findings resembled the earliest stages of cervical malignancy to such an extent that for a year ice treatment was suspended pending further study and follow up. Biopsies were taken from the cervices of these patients at monthly intervals and the literature was carefully searched for evidence of carcinogenic properties of dry ice.

Fig. 4. Biopsy taken four weeks after treatment. Note atypical cells in surface epithelium.

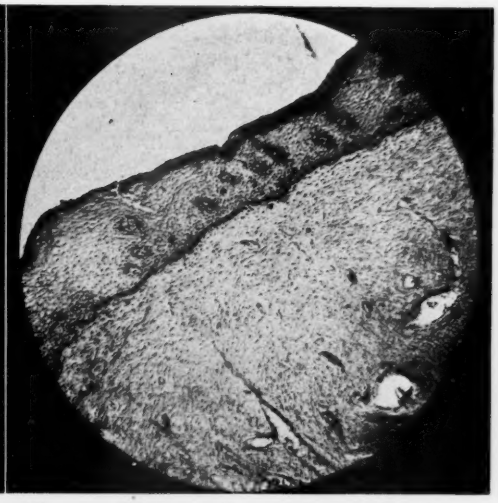

Fig. 5. Biopsy taken eight weeks after treatment. Healed cervix.

Two hundred and one biopsies were taken from the cervices showing the atypical cells. The number of biopsies from the same individual varied from one to seven. The duration of observation ranged from one to two and a half years. On the basis of this follow-up the following statements may be made:

1. All cases had erosions prior to the ice treatment.

2. The number of ice treatments had no influence in the development of atypical cells.

3. The atypism was observed as early as one week after treatment.

4. The duration of the atypism ranged from three months to over two and a half years.

5. Cases with atypical cells showed macroscopically a perfectly smooth normal cervical surface.

Berenblum in 1929 and 1930 published two articles dealing with his experiments with dry ice. He concluded that dry ice has no carcinogenic properties, either in animals or in human beings. Thus it appears that these nests of atypical cells have nothing in common with true malignancy. They may be regarded as signs of increased activity of the stratified squamous cell epithelium in a healing erosion.

RESULTS

Three hundred and twenty five patients received ice treatment. The first was treated in May, 1934, the last in December, 1935. In the beginning, the action of dry ice was not thoroughly understood and the results were not uniform. The present routine was gradually worked out. Since its perfection the results have been gratifying. Seventy per cent of the patients required only one ice treatment for a cure. Cases with erosion responded more readily to the treatment. Fifteen per cent required two ice treatments, and 15 per cent were treated three or more times.

No postoperative sequelae such as bleeding, inflammation or stenosis of the cervical canal have been observed to date. No

patient required hospitalization. The discomfort to the patient was minimal.

These findings and observations recommend the treatment with dry ice as a good conservative procedure in the treatment of endocervicitis.

SUMMARY

1. Topical application of a dry ice rod to the cervical canal for sixty to ninety seconds is offered as a new method of treatment of endocervicitis.

2. Dry ice belongs to the thermal agents of treatment.

3. This method was used for eighteen months in 325 cases. The cases were observed for two and a half years.

4. The results were very gratifying especially where cervical erosions were present. Seventy-five per cent had such erosions.

5. In 70 per cent of the cases only a single application of dry ice was necessary; 15 per cent required two treatments; 15 per cent needed several applications to achieve cure.

6. The treatment with dry ice is simple and painless. No unfavorable sequelae were noted.

7. The area of destruction is limited.

8. The inflammatory reaction after ice treatment is surprisingly minimal, cicatrization is entirely absent.

9. Dry ice markedly stimulates the growth of the stratified squamous cells.

10. Atypical cells in atypical arrangement were observed in 30 per cent of the cases as a result of this stimulation.

11. Two hundred and one biopsies were studied for a period of two and a half years. No evidence of true malignancy was observed. This atypism is only a sign of accentuated activity on the part of the stratified squamous epithelium.

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GRANULOMA VENEREUM (INGUINALE)*

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GRANULOMA inguinale is a chronic inflammatory disease of disputed venereal origin, clinically characterized by ulcerosclerosing lesion of the skin and mucous membranes of the genito-inguinal regions, and histologically by the presence of Donovan bodies in the monocytic cells of the exudate.

In medical literature it has been variously designated as "granuloma pudenda tropicum," "granuloma genito-inguinale," "ulcerating granuloma," "granuloma venereum," etc. The term lymphogranuloma inguinale which applies to a different disease entity has led to considerable confusion.

The etiology of granuloma inguinale still remains unsettled. From 1882 to 1905, the lesion was frequently considered tuberculous.[8–11] Claims for spirochetal etiology were frequently made[12–15] until 1905, when Donovan reported intracellular organisms supposedly protozoa.[16] Now recorded in the literature as Donovan bodies, these structures are constantly associated with the disease and, though diagnostic, have not as yet fulfilled Koch's postulates. In this country, Symmers and Frost in 1920 were the first to recognize Donovan bodies in this lesion.[17] Other interpretations, however, have also been placed upon the nature of these inclusions. Siebert[18] and Martini[19] in 1907 interpreted them as diplococci. After cultural studies Aragao and Vianna[20] interpreted them as schizomycetes. In 1917, Walker[21] and later Randall, Small and Belk[22] and others viewed them as Bacillus mucosus capsulatus. Castellani and Mendelsohn[23] in 1929 cultured Gram-negative organisms possessing morphologic characteristics of Donovan bodies, but did not consider them as the true cause of the disease, for inoculation produced only purulent lesions. MacIntosh[25] transmitted the lesion in the human by tissue graft and from such sites Donovan bodies were found on smear and culture. He believes the Donovan body to be the cause of the disease and excludes a filtrable virus.

Clinically, the disease is characterized by extreme chronicity and the absence of any tendency towards spontaneous healing. Although rectum, vagina, urethra, mouth and pharynx have been attacked, the disease shows a predilection for the external genital organs and perianal regions. In the female it often invades the vagina but only rarely has the cervix been affected. Pund and Greenblatt[25] very recently recorded two patients with involvement of the cervix uteri, one erroneously treated as carcinoma until pathologic study was made. Pund and Gotcher[26] have reported cases involving uterus, tubes and ovaries.

The period of incubation is varied. Cases with only two days' interval from the time of sexual contact are on record, others extend to three months. There are rarely any constitutional symptoms in this interval or after the appearance of the lesion. Locally, there is little pain though disturbances vary according to the organ involved, e.g., rectum, vagina, etc. Chafing, a burning sensation and itching are generally described.

Though most common in tropical countries, granuloma inguinale is not rare in the United States.[1,2] It occurs as a rule during adult life, but cases are recorded in children of 2 and 6 years.[3,4] A rare case reported by Scott[5] was found in a 67 year old male. Racially negroes predominate, probably

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the result of lack of sex hygiene rather than any special predisposition. Sexual congress is believed to be the underlying cause.

Fig. 1. Case 1. Gross appearance of the hypertrophic form of granuloma inguinale. Both labia are the seat of firm papillary and bulbous elevations. Superficial ulcers are present. Note the posterior butterfly extention onto the buttocks.

D'Aunoy and von Hamm,[27] whom we freely quote below, excellently describe the gross features and divide them into three groups. Group 1 lesions, caused primarily by the infectious agent, comprise nodular elevations and serpiginous ulcers. The nodules are usually only the beginning stage of infection and undergo further changes which lead to development of the serpiginous ulcer, the most common and most typical manifestation of the disease. The lesion is characterized by a soft, easily bleeding granulation tissue which breaks through the epithelial lining of the skin and mucous membrane and shows a remarkable tendency towards superficial spread along the moist folds of the inguinal and pudendal regions (Manson). These lesions are only a few millimeters deep and usually show very little suppuration. The exudate is serosanguineous, contains the infectious agent and spreads the disease by autoinoculation. The rapidity with which the infection spreads varies considerably and healing may be observed in some portions of the lesion while other parts show continuous encroachment upon sound tissue. During the course of the disease considerable areas of the skin and mucous membranes are usually covered with these ulcerative lesions, with resultant severe anatomic mutilation of the genitalia and the perineum. The healing process is slow and the scars produced are atrophic with partial depigmentation of the skin and permanent loss of hair.

The second group of pathologic manifestations is the result of a peculiar host reaction to the infectious agent, leading to hypertrophic and keloid-like lesions. The surface of the hypertrophic lesions may be compared to the relief map of mountainous country, with depressions between areas of piled up tissue. In consistency the lesions are firm and rather elastic, the overlying skin usually showing scars of previous ulcerations. There is often very little difference between this type of lesion and the true cicatricial or keloid-like lesion. In the latter there is an apparent over-production of firm, indolent tissue which replaces the ulcerations. This is not a healed stage of the disease, but a progressive lesion, as confirmed by the fact that the histologic examination shows the presence of Donovan bodies in the small nests of inflammatory cells embedded in the dense colagenous fibrous tissue obtained from such scars.

The third group of pathologic manifestations of granuloma inguinale consists of the lesions that occur as complications of the primary infection. The most frequent is secondary infection with aerobic or anaerobic pyogenic or saprophytic organisms. The onset of a virulent secondary infection is usually characterized by the appearance of toxic constitutional symptoms which are completely absent in the uncomplicated forms of granuloma venereum and by progression of the ulcerative process with the production of deep severe necrosis of soft tissues and even bone.

Microscopically, granuloma inguinale reveals in the pure or unmixed cases a uniform histologic picture. The essential features are: (*a*) hyperkeratosis which may be adjacent to areas in which the surface

epithelium is becoming ulcerated; (*b*) acanthosis; (*c*) elongation of the rete pegs; (*d*) dyskeratosis of the accelerated type

Fig. 2. Case 1. Histology of granuloma inguinale (× 120). The surface epithelium shows hyperkeratosis. Elongation of the rete pegs with parakeratosis and suggested pearl formation are dominant characters. The underlying connective tissue contains the inflammatory exudate.

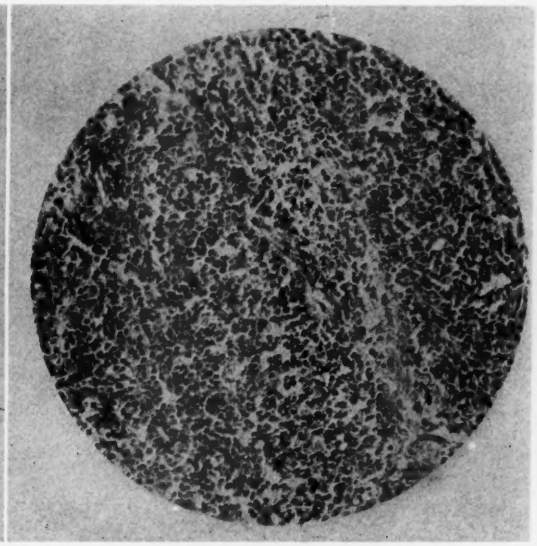

Fig. 3. Case 1. The inflammatory exudate in granuloma inguinale is predominantly of the plasma cell type. Monocytes, lymphocytes and occasional neutrophiles are also encountered. (× 120.)

which in some areas is such as to suggest pearl formation; (*e*) a nonspecific inflammatory infiltrate in the corium, in which plasma cells abound though neutrophiles and small round cells may be present; (*f*) varying amounts of fibrous tissue deep in the lesion; and (*g*) the pathognomonic cell with inclusion Donovan bodies.

The pathognomonic cell is most distinctive. It is a relatively large monocyte varying from 25 to 90 microns in diameter. The many intracystoplasmic cysts are filled with deeply stained bodies varying from .5 to 2 microns. These bodies as seen with hematoxylin-eosin are round or rod-like and are grouped peripherally within the cysts. They show strong affinity for this dye. In smears stained by Wright's technique the Donovan bodies show an unstained or feebly stained body with a centrally placed bacillus-shaped or minute coccoid chromatin body and a distinct well stained capsule. The central body may also appear as diplococcoid or diphtheroid in structure. Atypical forms, such as non-encapsulated bacillary or diplococcoid forms surrounded by a zone of rarefaction and zooglear forms, are frequently seen. The varied interpretations of the organism's nature may be easily explained by this pleomorphism. The silver stain in tissue simplifies identification of the organisms.

The diagnosis in spite of the characteristic gross appearance is not simple. Chancroid, however, is easily differentiated. This is an acute disease, painful and associated with buboes. The ulcers are phagedenic and frequently yield to local treatment. Ducrey's bacillus may be found on smear. Tuberculosis is excluded only on microscopic appearance. The finding of tubercle formation and demonstration of tubercle bacilli are conclusive. The coëxistence of syphilis and granuloma inguinale may be misleading. The presence of treponemata in the chancre or the classical microscopic appearance of gumma easily establish lues. In doubtful cases response to arsenical therapy is diagnostic. In the external genitalia, granuloma inguinale is frequently diagnosed as carcinoma. The two cases reported here were seen in a cancer hos-

pital. Vulvar carcinoma as well as cancer of the skin in general, however, is rare in negroes who are so frequently subject to

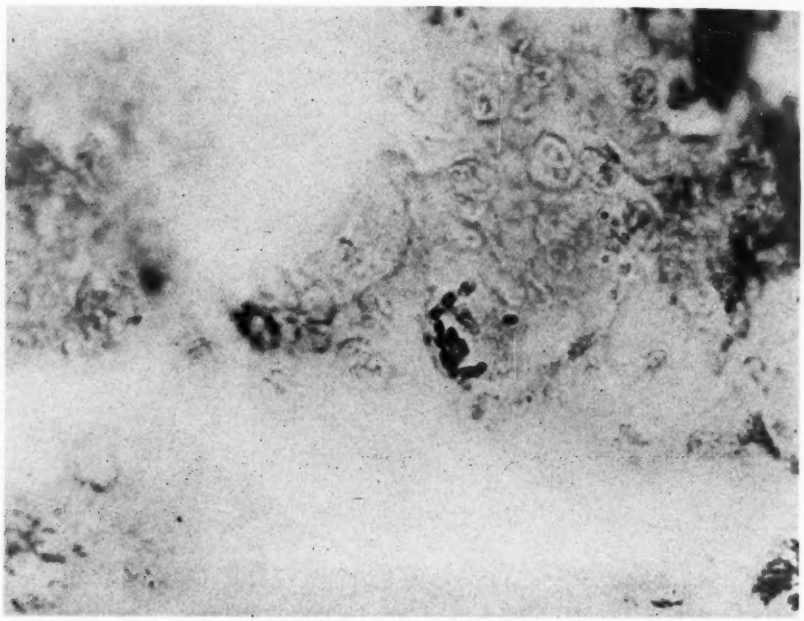

FIG. 4. Case 1. A group of intracellular Donovan bodies heavily impregnated with silver. Their oval form and peripheral accentuation of stain are characteristic. (× 2200.)

granuloma inguinale. In carcinoma there are often vestiges of leucoplakia. Absence of lymph node enlargement in granuloma inguinale is especially striking when considering the wide extent of the local lesion. The microscopic picture is of course distinctive but hyperplastic and acanthotic changes in granuloma inguinale may sometimes lead to confusion.

Lymphogranuloma inguinale or lymphopathia venereum is most frequently confused. Clinically, lymphogranuloma inguinale is a disease of the lymph nodes and lymphatic channels while granuloma inguinale is a disease of the skin and subcutaneous tissues. The primary lesion in lymphogranuloma inguinale is rarely encountered on the external genitalia. The vagina or cervix are the primary seat. The initial lesion heals quickly so that it is seldom found. Enlargement and suppuration of the inguinal lymph nodes is frequently the first finding. In late cases a stricture of the rectum is encountered. The positive cutaneous response to injected antigen obtained from suppurating lymph nodes or from the virus-infected mouse brain (Frei test) is specific for lymphogranuloma inguinale. Even in cases where ulceration of the skin or genitalia appears, lymphogranuloma inguinale is identified by its microscopic appearance and the Frei test. Donovan bodies are lacking. The specific response to antimonials in granuloma inguinale may also be used as further diagnostic evidence. We again emphasize the use of silver stain for identification of Donovan bodies in biopsy specimens.

Treatment in the early days of the disease consisted of radical surgical extirpation of the lesion. Local recurrences, however, were the rule. Coagulation,[28] *x*-ray therapy,[20] vaccines,[30] have all been employed. Antimony, which is a specific cure for granuloma inguinale, was first employed by Aragao and Vianna of Brazil. Tartar emetic given intravenously is advised, beginning with 2 c.c. of a 1 per cent solution in distilled water, slowly increasing the dose until 10 c.c. is reached. Injections are given every second to third day and continued weekly for two to three months after healing has occurred to prevent local

recurrences. It is believed that not more than twenty to thirty injections should be given in a course. Nausea, dizziness, bone pain or diarrhea may necessitate a temporary halt.

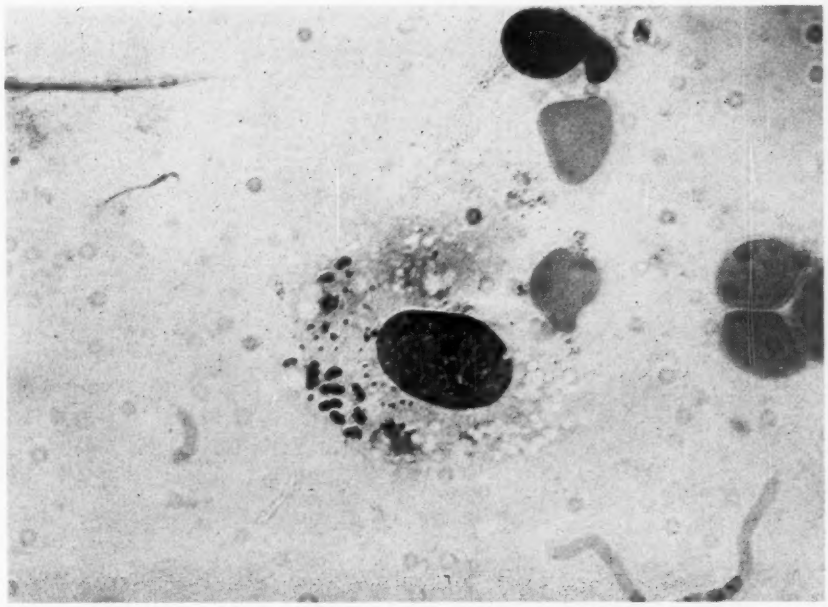

Fig. 5. Case 1. A monocytic cell, large and containing a deeply staining oval nucleus. The cell cytoplasm contains many vacuoles. At the periphery of the cell are classic Donovan bodies. They present a well stained capsule with central coccoid, diplococcoid and bacillary structures. (× 1870.)

More recently a newer antimony compound has become available which can be used intramuscularly.[31] This drug, called fuadin, was first introduced by Khalil of the University of Cairo for the treatment of bilharziasis. It was first employed for granuloma inguinale by T. V. Williamson in this country in 1933.[32] Fourteen cases were reported in his series with excellent results. Treatment begins with 1 c.c. of the drug administered intramuscularly, increasing the dose until 5 c.c. is employed. Injections are given two to three times a week until healing occurs. In rare cases where antimony is contraindicated or produces no results, surgery, *x*-ray or coagulation must be resorted to.

CASE REPORTS

Case 1. Mrs. J. J., age 55, mulatto, was first seen in the gynecological department in October, 1935 when she complained of vulvar itching and a bleeding sore in the region of the external genitals. Symptoms had begun six months prior to her visit and had become progressively worse. The itching was so severe that rubbing and scratching for relief were almost constant. Later, white pimples appeared which broke down, bled, became red and increased in size. A discharge was also present and both symptoms were aggravated by walking. She had had sexual intercourse with a West Indian six weeks before the appearance of her complaints. There was no other exposure and the family and past personal history were otherwise negative. She denied lues and gonorrhea.

Examination revealed a granular elevated lesion which involved the labia majora and minora on each side, extending from the clitoris to the fourchette. (Fig. 1.) There was also butterfly extension toward the anus and on the posterior vaginal wall for 1 inch. The surface of the lesion presented fine granular excrescences and also round or ovoid nodules. Focally there were zones of superficial necrosis from which a fetid serosanguineous fluid exuded. In the posterior extension the external surface of the lesion was smoother but its demarcation from healthy skin was sharply indicated by a raised indurated margin. The inguinal nodes were not enlarged.

Several biopsies were taken which were variously reported as dyskeratosis, with marked inflammation and prickle cell carcinoma. The

Fig. 6. Case 11. The labium minus partially destroyed by a granulomatous ulcer with a thickened serpiginous margin. Two smaller ulcers just anterior to the anus are also shown.

Frei test and Wassermann examinations were negative. The blood count was normal. Smears studied for Donovan bodies at this time were erroneously reported as negative. A diagnosis of granuloma inguinale was made but since several observers believed the lesion to be carcinoma of the vulva, the patient was admitted for operation on December 3, 1935.

The vulva was first treated with antiseptic dressings of acriflavine for disinfection of the wound for a period of twelve days. On January 15, 1936, vulvectomy was performed under ether anesthesia. The postoperative course was uneventful until the fourth day when beginning necrosis required removal of the sutures. Acriflavine dressings were reapplied and healthy granulations became apparent on the tenth day. On the twenty-first day postoperative, due to tardy healing, 5 c.c. of fuadin were given intramuscularly and continued twice weekly. Healing then progressed more satisfactorily and upon discharge from the hospital on March 6, epithelization was well advanced, but edema of the right labium was present. Fuadin was continued every fourth to seventh day, for a total of fifteen injections. Although healing was complete, the lymphedema of the right labium persisted and was treated by *x*-ray therapy from June 15 to June 29, 1936. One hundred fifty radiation units were given every second day, until 750 R. units were administered. The factors were: 40 cm. S.T.D., 200 Kv., 5 M.A.; ½ mm. copper and 1 mm. Aluminum filters.

On September 15, 1937, twenty-one months after operation, a recurrent ulcer 2.5 cm. in diameter appeared on the right buttock just a little below the anus. Nine injections of fuadin were given, starting with a dose of 1.5 c.c. and increasing the quantity until 5 c.c. were administered. Six weeks later the lesion was entirely healed. The patient seen early in 1938 was clinically well.

The pathologic report of the operative specimen showed that the epithelial layer was the seat of areas of hyperkeratosis and dyskeratosis, the latter resulting in marked hypertrophy of the rete pegs with extension deep into the dermis. (Fig. 2.) There was no evidence of malignant change of the cells of the epidermis. The cutis and the subcutaneous structures were involved in a marked and extensive exudate. The plasma cell predominated but lymphocytes and monocytes were encountered. (Fig. 3.) There was a superimposed acute inflammation accompanied by ulceration of the epidermis, at which sites the acute inflammatory exudate replaced the superficial layers of the epidermis. The conclusion was that the case was one of granuloma, with superimposed acute inflammation and ulceration. Reëxaminations of the excised operative specimen and the biopsy tissues were made with the Dieterle silver method (Fig. 4) and typical Donovan were easily disclosed. Smears from the recurrent lesion in 1937, stained by the Wright method, also showed the organisms. (Fig. 5.)

The lesion in this case was of the nodular type. Despite widespread involvement of the vulva and inguinal zones, the lymph nodes were not involved. Surgical excision was not entirely satisfactory, but there was prompt healing of the operative site after the use of fuadin. A recurrence twenty-one months after operation also responded quickly to the use of this agent. The diagnosis of granuloma inguinale was easily made in the operative and earlier biopsy specimens during their restudy. The silver stain was especially helpful in find-

ing the classical Donovan bodies in excised tissues.

Case II. Mrs. M. H., age 54, colored, was

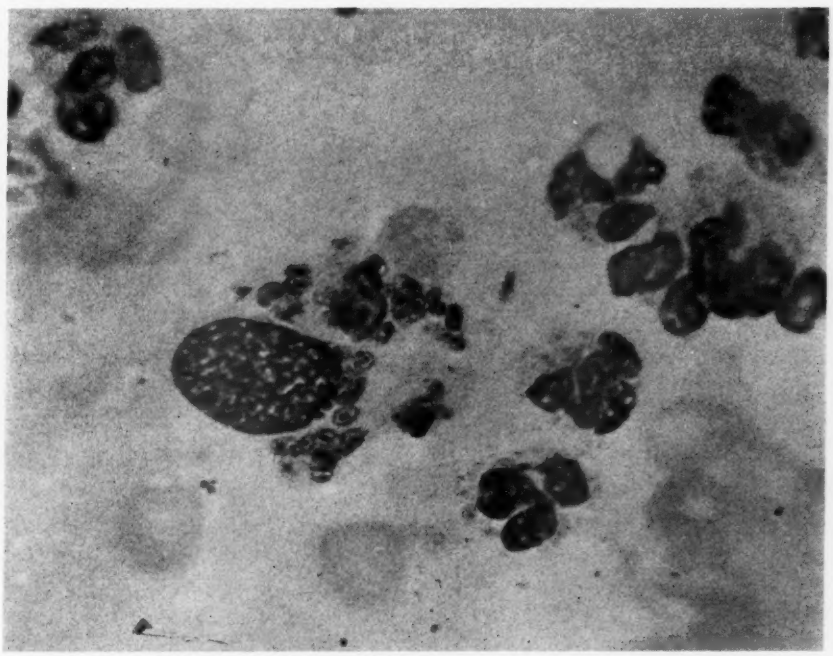

Fig. 7. Case II. The large deeply stained nucleus of a monocyte is clearly shown. The cell cytoplasm is hardly visible. Mature Donovan bodies, irregularly distributed, show a well defined capsule with central diplococcoid, bacillary and diphtheroid formations. (× 2100.)

first seen in May 1937. She complained of itching and a sore on her vulva and groins present since 1935. Coitus in the past six years was denied. The sore started as a pimple near the vulva and gradually increased in size. There was no pain. The lesion was interpreted as luetic in origin because of a positive Wassermann and a series of salvarsan injections was given but without result. The patient was accordingly referred by the Health Department to the Brooklyn Cancer Institute in 1936 for a biopsy. A pathologic diagnosis of pyogenic granuloma was made and the patient returned to the Board of Health for continued observation and luetic treatment. No improvement was obtained. In May 1937, the gynecologic examination showed the following: the right labium minus was partly destroyed by a granulomatous ulcer which extended from a point just below the clitoris downward for about 4 cm. (Fig. 6.) It was irregular in outline and measured 4 × 3 cm. Laterally it reached the labium majus and medially encroached upon the introitus and vagina. The floor of the ulcer was somewhat granular, elevated about 2 or 3 mm. and covered with a scant, serosanguinous, foul discharge. The edge of the lesion was sharply defined, thickened and rolled. It was distinctly serpiginous. On the fourchette, just anterior to the anus, were two additional small lesions about 1.5 cm. in diameter, having similar characteristics. In the right groin, there was an oval lesion 3 × 2.5 cm. whose center was more elevated. The edge of the lesion had the same characteristics, but was not serpiginous. Below this area, there was a healed depigmented scar. In the left groin there was a cord-like thickening but distinct nodes could not be palpated in either groin. The vagina and cervix were normal. Except for two external hemorrhoids, rectal examination was negative.

The Wassermann and gonococcus fixation tests were negative. Injection with Frei antigen produced a positive nodule 12 mm. in diameter. The blood count was negative except for moderate eosinophilia. Urine examination was negative. The sedimentation time was 25 minutes. Smears from the ulcer stained by Wright's method were positive for Donovan bodies. (Fig. 7.)

The first biopsy, taken in 1936, showed tissue covered by a thickened, stratified squamous

lining epithelium infiltrated by polymorphonuclear cells. Beneath this there was a rich leucocytic infiltrate containing numerous neutrophiles and plasma cells. Areas of necrosis and pycnotic nuclear débris were intermingled. Collections of young connective tissue cells were frequent. In our restudy with hematoxylin and eosin and Dieterle techniques, Donovan bodies were found in the monocytic cells of the exudate. (Fig. 8.)

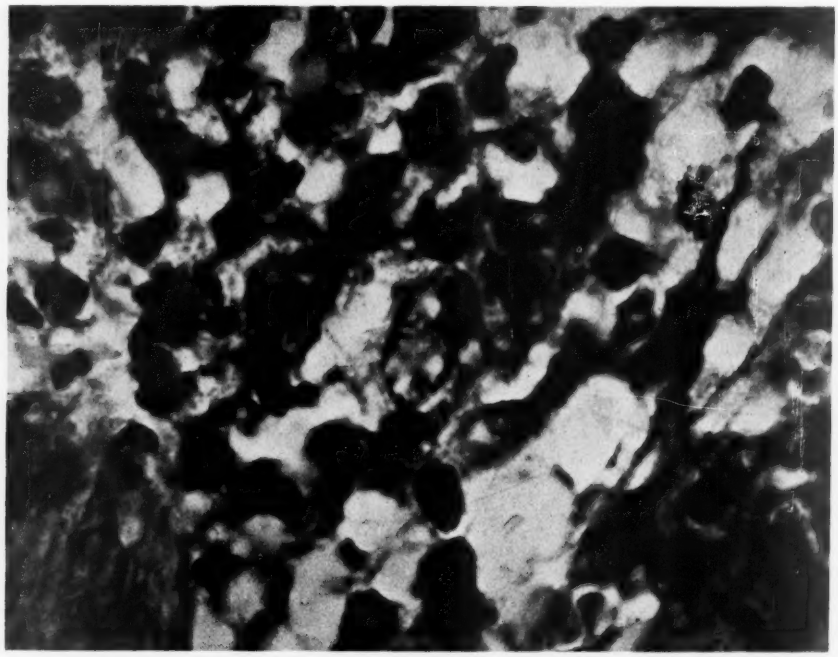

FIG. 8. Case 11. A large monocyte lies in the center of the field. The deeply staining nucleus is eccentrically placed. The cell cytoplasm presents characteristic multiple cysts. Donovan bodies are present though poorly reproduced in the photograph. (× 2000.)

Fuadin therapy was administered by intramuscular injections. On May 8, 1937, 1.5 c.c. was given, followed by 5 c.c. on May 11, 14 and 15. On May 18, the margins of the vulvar ulcers were noted to have flattened out, and the edges were less distinct. The bases soon appeared as smooth pale pink areas covered with a thin secretion. The groin lesion was also smaller but did not show such prompt regression. The patient left the hospital and was referred to a private physician for observation. In November, 1937, the lesions were entirely healed with the formation of depigmented scars. Repetition of the Frei test in November, 1938 showed a large papule, indicating the coincidence of lymphogranuloma inguinale with granuloma inguinale or a repeated false positive reaction for lymphogranuloma.

In this case there was a coexistence of a positive Wassermann, positive Frei test, and positive smear for Donovan bodies. Salvarsan therapy produced no effect on the classical ulcerative type of lesion. Absence of enlarged lymph nodes and prompt response to fuadin excluded lymphogranuloma as the cause of the vulvar lesion. Early pathologic study failed to show the etiology of the lesion, but reëxamination of the tissue two years later by the silver technique showed numerous Donovan bodies which were also present on smear examination. The rapid response to the small amount of fuadin was striking.

CONCLUSIONS

1. Granuloma inguinale is a chronic inflammatory lesion of the skin and subcutaneous tissues. It occurs most frequently in the colored race. The genito-inguinal region is the site of predilection. It appears in hypertrophic and ulcerative forms which are often mistaken for carcinoma.

2. Extensive vulvar lesions with absence of enlarged regional lymph nodes is clinically characteristic.

3. Pathologic reports on such lesions are often erroneous or incomplete, yet the microscopic picture is distinctive. The finding of Donovan bodies is conclusive.

4. A search for these bodies should be made in all genito-inguinal lesions presenting the clinical and pathologic features described. Smears and tissue sections show the organisms.

5. The Dieterle silver stain is a great aid in the microscopic diagnosis of Donovan bodies in excised tissues. The Wright technique is similarly satisfactory for examination of smears.

6. The use of antimony is specific and fuadin is the ideal drug.

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ANALYSIS OF FIFTY CASES OF PERFORATED PEPTIC ULCER*†

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THIS study is based on a consecutive series of fifty cases of perforated peptic ulcer in which operations were performed in the seven year period from 1931 to 1937 at the Cumberland Hospital. Gastric as well as duodenal perforations are included, since the clinical picture and course are so similar that one may discuss both under the subject of perforated peptic ulcer. The operations on these patients were performed by a number of surgeons on the various surgical services of the hospital.

It is interesting to note that this group consisted entirely of males. In the past fifteen years, there has been no case of an operation for perforated peptic ulcer performed on a female patient at this hospital. One female patient was admitted, however, for recurrent ulcer symptoms and gave a history of a previous perforation for which she had been operated upon at another hospital.

There were six colored patients in this series, giving an incidence of 12 per cent, which corresponds to the percentage of colored patients admitted to this hospital.

The ages varied between 23 and 63 years, with an average age of 39 years. There were twenty-five perforations in patients between the ages of 35 and 50 years inclusive. (Chart I.)

Twenty-seven cases of the total series occurred in the fall months, during September, October and November. (Chart II.)

Of forty-three cases in which an inquiry was made of symptoms suggestive of peptic ulcer prior to perforation, all but one gave such a history. The duration of these symptoms varied from one day to twenty-five years, with an average duration of three and one-half years. Eleven of these patients had symptoms of one month's duration or less. A good number gave a history of an acute exacerbation of symptoms immediately prior to perforation. In three cases there had been positive *x*-ray findings of ulcer at some time prior to admission. Three patients had had a previous perforation, two, three, and seven years previously, respectively. Two cases perforated on the wards of the hospital, one five hours following a gastric analysis, and another during the course of observation for severe ulcer symptoms. (Chart III.)

Part of the diagnosis of a ruptured peptic ulcer therefore depends on eliciting a history of previous peptic ulcer symptoms, with an aggravation of these symptoms immediately prior to admission. All these patients experience a sudden, sharp, severe pain, located in the epigastrium (forty-two out of fifty), or occasionally around the umbilicus (six cases), or in the right lower quadrant (two cases). The pain then radiates to the right or left shoulder or both in a majority of cases (62 per cent), and occasionally to the right lower quadrant (in 21 per cent). Nausea and vomiting are infrequent symptoms. A history of the presence or absence of vomiting was elicited in thirty-nine cases. It was absent in twenty-one cases (or 42 per cent of the total) and, where present (in 36 per cent of the total), the patient gave a history of vomiting but once. The reason for this, is perhaps the "spill" of gastric and duodenal contents into the peritoneal cavity.

Abdominal muscular rigidity comes on immediately, and is "board-like" in character. This was noted over the entire abdomen in 64 per cent of the cases, limited to the right side in 14 per cent of the cases,

* From the Surgical Service, Cumberland Hospital.

† Presented at Brooklyn Day, American College of Surgeons Congress, October, 1938.

and limited to the upper abdomen in 22 per cent. It is interesting to note that most of the cases in which rigidity was limited to the right side were ruptured duodenal ulcers, a helpful point in differentiating this type from ruptured gastric ulcers. The reason for this may be that the "spill" in ruptured duodenal ulcer is mainly along the right colic gutter. In a majority of cases, tenderness and rebound tenderness were elicited over the entire abdomen, with maximum tenderness in the epigastrium. In one-third of the cases of duodenal perforation the maximum tenderness and rebound were noted on the right side. This is important to remember in differentiating this condition from acute appendicitis. In twenty-six cases, the patient was examined for the presence or absence of liver dulness. Twenty, or 76 per cent, showed liver dulness to be partially or completely obliterated—a very important sign. The white blood count averaged 14,500, with 80 per cent polymorphonuclear cells. It was interesting to note that duodenal perforations gave a somewhat higher average (16,000) than gastric and pyloric perforations (13,000).

In considering the differential diagnosis of this condition, it is necessary to stress the importance of differentiating acute appendicitis from ruptured duodenal ulcer. In our series an incorrect diagnosis of acute appendicitis was made in five cases. In all these cases, the symptoms were found to be due to a perforated duodenal ulcer, making a 31 per cent error in the diagnosis of this condition. The reason for this incorrect diagnosis in ruptured duodenal ulcer is evident: the duodenal contents drain down the right colic gutter, causing a definite irritative chemical perityphilitis and periappendicitis, the symptoms of which mask the correct diagnosis.

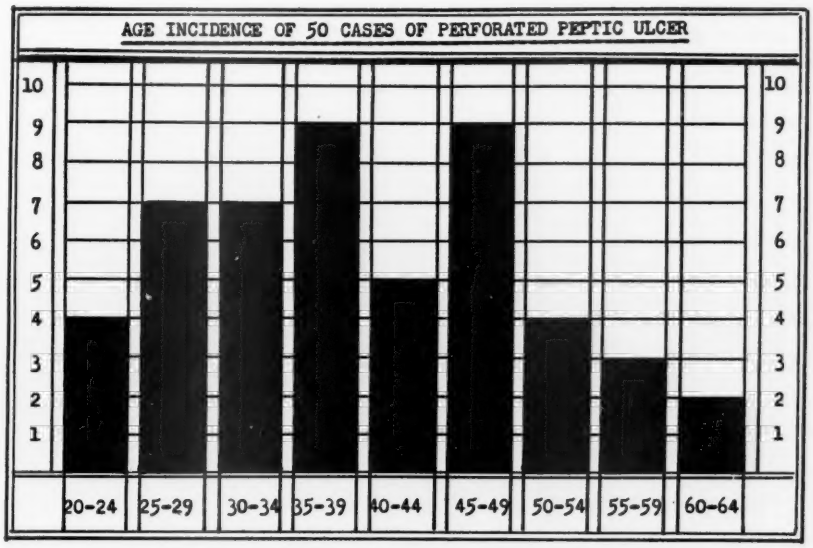

Chart 1.

Of the fifty cases, there were forty-eight in which the exact interval of time between perforation and operation could be determined. This varied between two hours and twenty-eight hours, with an average interval of seven hours. The average interval in those patients who survived was 5.93 hours, and in those who died 8.21 hours.

Of the twenty-nine patients who were operated upon within six hours, five died, a mortality of 17 per cent. Fifteen patients were operated upon within six to twelve hours from the time of perforation, and of these, five expired, a 33 per cent mortality. Of the two patients operated upon from twelve to eighteen hours afterward, one died, a 50 per cent mortality. One, operated upon at twenty-one hours, died. One

patient gave a history of having perforated twenty-eight hours before operation and survived. The history in this case, however, was obtained through an interpreter so that doubt may be cast on its veracity. As has been pointed out repeatedly by many writers, the mortality in these cases sharply rises as the time between perforation and operation increases. (Chart IV.)

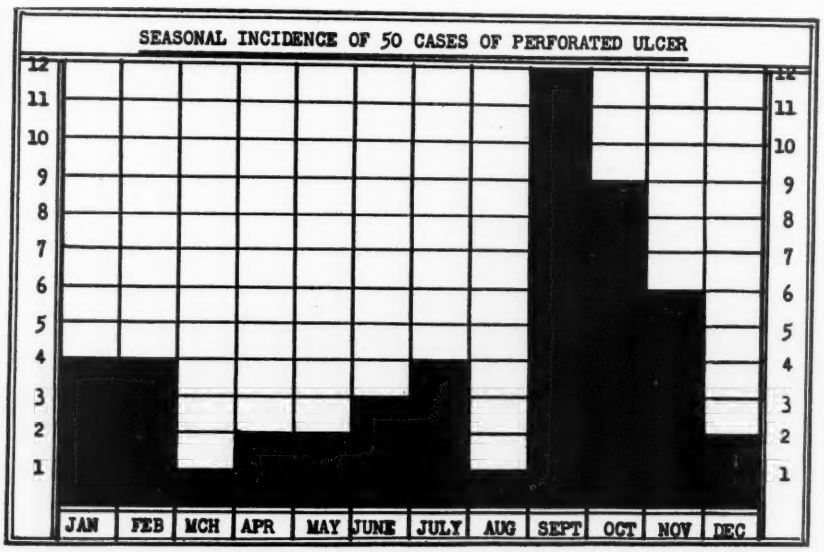

CHART II.

The location of the perforation was determined at operation in all cases. All were on the anterior wall, and all within 2 inches of the pylorus on the gastric or duodenal sides. In twenty-seven cases, the perforations were on the gastric side, mostly near the lesser curvature; in seven directly at the pylorus, also near the lesser curvature; and in sixteen cases in the first portion of the duodenum.

The size of the perforation varied from a "pencil point" to 1 cm. in diameter. An area of induration was usually noted about the perforation varying from 1 to 5 cm. in diameter. The fluid present at the time of operation varied in quantity from 100 c.c. to 2,000 c.c. and also varied in color and consistency. It was generally noted that those who expired had a greater amount of fluid in the peritoneal cavity than those who survived.

The actual operation, with the exception of one patient who had a gastroenterostomy, was of the simplest character, performed in all but one case under general anesthesia. The operation consisted of the aspiration of the fluid, followed by a purse-string suture of the perforated area. This was reinforced with a continuous Lembert suture and then with a piece of omental graft. Drainage was instituted in a majority of cases. Forty-four of the fifty were drained by Penrose or rubber tube drains or both. Of these, ten expired, a mortality of 23 per cent. In six cases no drainage was instituted, and no deaths occurred. Only in very early cases, under twelve hours' from the time of perforation, was drainage not instituted. The average duration from perforation to operation in these cases was 5.2 hours. An attempt was made to determine the difference in the postoperative course of these drained and non-drained cases, but no conclusions could be reached because of the insufficient number of cases treated without drainage, and because of the occurrence of extra-abdominal complications in these cases.

Pulmonary complications occurred in ten cases, a 27 per cent incidence. This is extremely high. The question might be raised whether this might not have been lowered with spinal anesthesia. Wound infection occurred in six cases, uremia in two cases and phlebitis in one case.

An analysis was made of the factors related to the outcome of the cases and of the causes of death in each case, as discovered at autopsy. There were thirteen deaths, of which four were duodenal (out of sixteen) and nine were gastric (out of twenty-six), a mortality of 26 per cent. There were no deaths in the cases of perforation at the pylorus. (Chart v.)

The importance of the time factor between perforation and operation in determining the outcome has been mentioned. There was no appreciable difference in blood counts between those who died and those who survived. The size of the perforation had very little to do with the outcome, but generally those who died had a greater peritoneal "spill." Cultures of the peritoneal fluid were taken at the operating table on twenty-three cases. Of these, eleven were sterile, and twelve showed growths of pathogenic organisms either in pure or mixed cultures. Of the eleven cases in which the culture was sterile, three died, and of the twelve cases with positive cultures, one died. Thus, this factor has little influence on the mortality.

Six autopsies were done in the thirteen fatalities. Five died of generalized peritonitis and paralytic ileus. One patient with a four plus Wassermann, was found to have died of a bilateral bronchopneumonia and luetic aortitis. Of the five cases with generalized peritonitis, three were clinically declared to have expired from "shock"; they died six, thirty-one, and thirty-six hours postoperatively. One patient developed a bronchopneumonia, then eviscerated on the tenth day, at which time he was reoperated upon, and found to have a generalized peritonitis. He expired on the table. There was no autopsy in this case. Six proved cases of generalized peritonitis were therefore among the thirteen deaths.

Of the cases in which no autopsy was done, one died twenty-one hours postoperatively with a steadily mounting temperature—probably another case of fulminating peritonitis. It seems improbable that these seven cases of generalized peritonitis, which account for 52 per cent of the total number of deaths, could have been saved by any procedure. The average

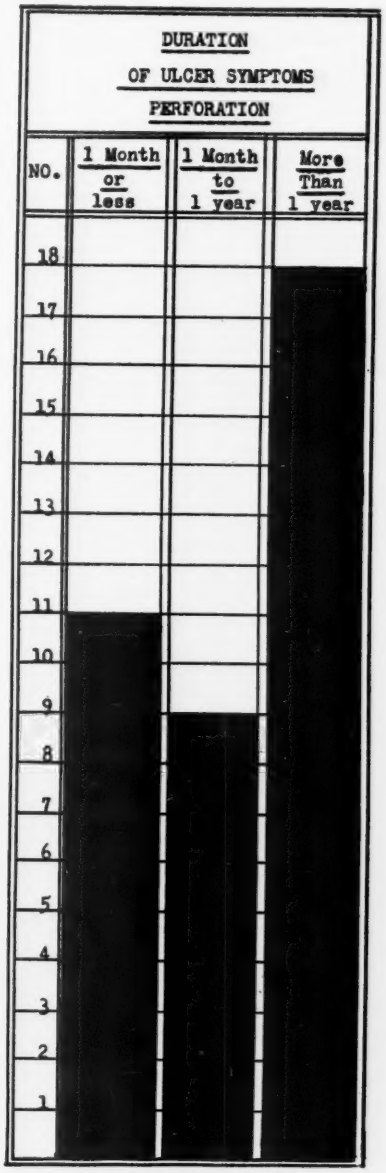

Chart III.

interval between perforation and operation in these seven cases was seven hours.

One patient developed bronchopneumonia on the sixth day and died on the tenth day. One expired on the fifth postoperative day and was suspected of having a continued leak because of the difficulty in closing the perforation at the time of operation. He had a perforation ¼ inch in diameter, surrounded by a large thick,

indurated area 1¼ inches in diameter. A futile attempt was made to purse-string this perforation, in the presence of edema-

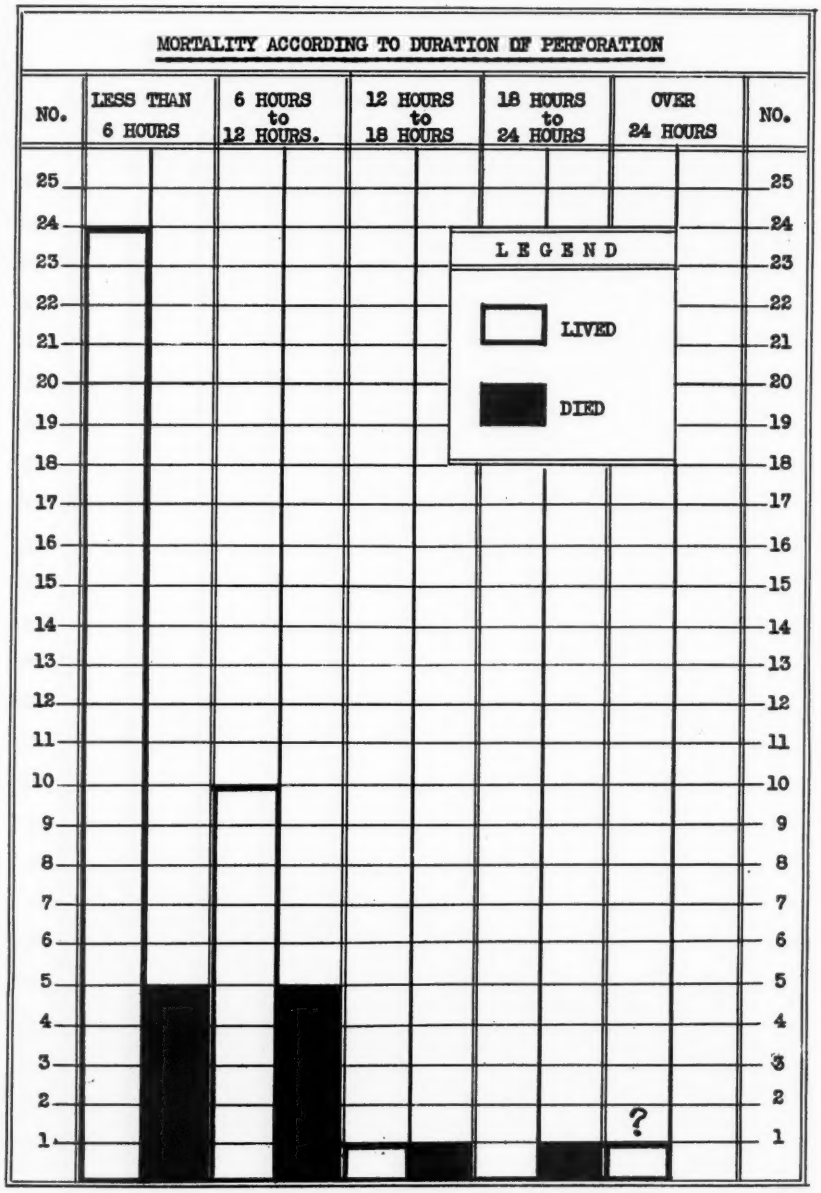

Chart iv.

tous friable tissue. This patient had a spill of 1,200 c.c. of fluid at the time of operation.

Three patients had developed shock during the operation, and never rallied subsequently. One of these gave a history of eight hours' duration from the time of perforation and was operated upon for acute appendicitis. The right lower quadrant was first explored, "considerable seropurulent fluid" noted, and the incision was extended upwards. On further observation, the intestines and omentum were found to be covered with a "white powder," taken at the onset of the symptoms of perforation. The total operating time was one hour and fifteen minutes. At the time the peritoneum was being closed, the patient's pulse suddenly became weak, and he expired two minutes thereafter on the operating table.

In the second case, the exact duration of the perforation could not be determined. The patient gave a history of vomiting and

epigastric pains for three days prior to admission, during which time he was probably having a subacute perforation. Two hours after admission, he suddenly complained of severe pain. He was immediately operated upon. His pulse was 130 per minute. He had a perforation 1 cm. in diameter, and another thinned out ulcerated area which "had almost perforated" in the middle of the lesser curvature, which was also purse-stringed. There were 200 c.c. of brownish fluid in the abdominal cavity. The total duration of the anesthesia was one hour and five minutes. During the operation, the patient's pulse became poor in quality. He was given intravenous fluids and he rallied somewhat. He expired, however, sixteen hours after operation in a state of shock.

The third patient was admitted and operated upon twenty-one hours after perforation, at which time he was moribund. His abdomen was markedly distended; he was cyanotic, dyspneic, and his pulse and blood pressure were unobtainable. The white blood count showed 3,100 white blood corpuscles. A "large perforation with a large amount of free fluid" was noted in the peritoneal cavity. He became progressively worse and expired nine hours postoperatively.

It is questionable if any of these cases would have been saved from shock and death by temporizing for several hours with preliminary shock treatment.

What happened to the thirty-seven patients who survived? Our follow-up concerns the twenty-seven cases followed. Of these, two died subsequently, one a year later of a gastric hemorrhage, and another nine months later following a posterior gastroenterostomy. Another patient was readmitted two and one half years later with severe gastric hemorrhage. He gave a history of having had two perforations which had been operated on and he was never free of symptoms. Seventeen patients, had no symptoms whatsoever, although four were still on a "diet." The remaining six patients, were fluoroscoped three to four weeks postoperatively, and five failed to show any radiographic evidence of an ulcer.

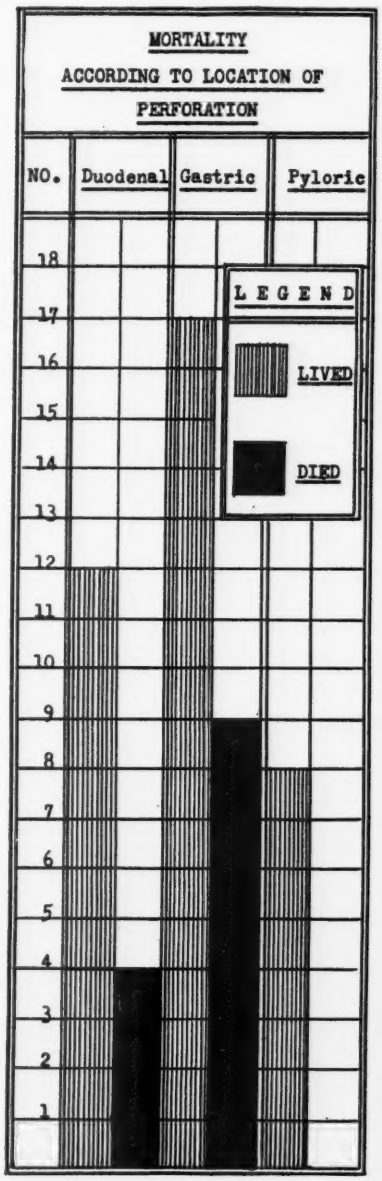

Chart v.

So one may say that, with the exception of the two patients readmitted for hemorrhage, most of the cases of ruptured ulcer were free of symptoms following their perforation.

SUMMARY

This study is based on a series of fifty cases of perforated peptic ulcer treated at the Cumberland Hospital during a seven

year period from 1931 to 1937. The average age of these fifty male patients was thirty-nine years. There appears to be a seasonal incidence for the occurrence of this condition. The majority of cases occurred in the fall months of September, October and November. Most of these patients had a definite history of peptic ulcer symptoms for an average duration of three and one-half years prior to perforation. The history of a sudden, sharp, severe abdominal pain followed by radiation of the pain to the shoulders appears important in the diagnosis of this condition. Objectively, the presence of marked abdominal tenderness, and rebound tenderness, with board-like rigidity of the abdominal muscles, and obliteration of liver dulness with a definite leucocytosis, make the diagnosis of the case conclusive. The most important factor in determining the outcome is the interval of time between perforation and operation. The mortality rises sharply as this length of time increases. The simplest of operative procedures, namely, aspiration of the fluid and closure of the perforation, carried out with the least additional trauma is the procedure indicated. Generalized peritonitis appears to be the cause of death in a majority of the fatal cases. It appears unlikely that this may be influenced in any way, by delaying operation to improve the patient's condition, or by changing the operative procedure. A follow-up study of 73 per cent of the cases revealed that most of the patients were entirely free of symptoms, at an average of one and one-half years following the perforation.

AN ANALYSIS OF THE CAUSE OF DIRECT HERNIAE FOLLOWING POSTOPERATIVE RECURRENCE OF INDIRECT HERNIAE*

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THE treatment of lower abdominal wall herniae is still an intriguing subject, both in Europe and America. At the 1934 meeting of the British Medical Association,[1] Mr. Page stated: "In spite of all the consideration given to it, agreement about the best method of treatment has not been reached, largely because the information about late results is inadequate and inaccurate—a close follow-up would reveal a larger percentage of recurrences than generally believed." His own confidence in operations on all cases had been shaken by his experience with the Metropolitan Police. A review of 241 operations in that group disclosed the fact that 11.5 per cent were for postoperative recurrence, and further investigation suggested the true rate to be even higher.

Block's analysis of continental figures gave a recurrence rate of 34.8 per cent after two years, the majority apparently direct herniae.

T. A. Hindmarsh (Newcastle) reviewed 102 inguinal herniae with nine recurrences and stated that a large proportion of recurrences were due to the wrong type of operation, but did not state the reasons for his conclusions. His rate was slightly over 11 per cent. E. M. Cowell (Croyden) reported a recurrence rate of 4.5 per cent. Thus in the hands of capable English surgeons with the best modern technique, it was found that the recurrence rate was 4 to 11 per cent or higher, depending on the follow-up method employed.

A statistical report of 826 herniae (1933 to 1934) reported by O'Shea[2] shows 11.5 per cent recurrence. Burdich and Higinbotham,[3] advocating the radical procedure of spermatic cord section in addition to other modern maneuvers to prevent recurrence, still had recurrences in simple herniae of 4.8 per cent, sliding 7.7 per cent, irreducible 6.5 per cent, and in postoperative cases a recurrence rate of 23.7 per cent.

Watson[4] makes the following observations and conclusions: (1) except for the rare traumatic type, all oblique herniae are congenital, regardless of age when first discovered; (2) congenital sacs in adults are more common than supposed and most men undoubtedly carry these potential sacs throughout life without incidence of herniae; (3) microscopic examination fails to show any difference between old and so-called new sacs.

Graham[5] states: "The congenital origin of most inguinal hernial sacs has been almost universally accepted for twenty-five years in this country, having been recognized by nearly all Workmen's Compensation Boards, who take the position that there is a distinction between a potential and an actual hernia—that it is an accident or injury of some kind that transforms the potential into the actual hernia. Even if a man has a congenital sac, but without the actual hernia, he is unconscious of the condition and can hardly be said to have a hernia, until there is a protrusion of omentum or viscus."

Thus in a review of the literature on the subject of direct and indirect herniae, one finds the following:

1. Many data covering varied types of operation and maneuvers for the purpose of avoiding recurrence.

* From the Daniel Baugh Institute of Anatomy, Jefferson Medical College of Philadelphia.

2. A general agreement in the statement that inguinal herniae have a congenital basis, with discussion pro and con upon the subject, as to what value should be given to the non-obliterated peritoneal sac or funnel as an actual cause of hernia formation.

3. A fairly uniform percentage of recurrence after operation when done by the best surgeons, with the most modern technique in both England and America. Also the surprising fact that the percentage of recurrences after operation for operative failure jumps from 11.5 per cent to 23 per cent.

In spite of all the discussion, both written and oral, upon the subject of hernia, the problem seems to be of as much interest and importance today as it was fifty years ago.

The material found in the literature brings certain fundamental questions to our attention, such as: (1) Why should the majority of recurrences be direct herniae when the original operations were for indirect herniae? (2) What is the important factor in hernia formation if the sac of peritoneum, intra-abdominal pressure or the viscus is not the primary cause of hernia?

In an endeavor to solve these questions, the thought occurred that in the original concept of hernia formation the effect rather than the cause was considered. A concept of effect naturally produced a tremendous interest in methods of repair and reconstruction, and resulted in innumerable maneuvers and modifications of surgical technique, none of which is universally successful in avoiding operative recurrence.

Many investigations have clearly shown that hernia is not caused by intra-abdominal pressure, nor by the presence of a congenital sac of peritoneum, nor by the protruding viscus, alone or in combination, and that in the majority of individuals, direct and indirect herniae will not develop unless the anterior abdominal wall muscles are torn, as in trauma. These facts led to the conclusion that there must be some other fundamental factor or factors which have not as yet received proper attention.

Study of the subject resulted in a description of an average anatomic type or pattern, and variations from the average type.[6,7] The latter I believe to be the important factor underlying hernia formation, i.e., the protrusion of a viscus. These muscle variations constitute an inherent weakness of construction in the anterior abdominal wall. They are caused by deviations in the embryonic development of the musculature and result in variations of pressure resisting efficiency. It can be demonstrated that in the presence of a viscus protrusion or hernia there is an almost constant finding of a variation from the average anatomic muscle picture.

For the purpose of this paper, I shall describe and discuss the average anatomic pattern and variations from the average anatomic type which I believe to be the fundamental cause of hernia formation, and shall attempt a rational explanation for the occurrence of direct hernia as a postoperative sequela of indirect inguinal herniorrhaphy, as well as suggestions leading to the general problem of inefficient anterior abdominal walls when due to variations in the musculature.

An average pattern of the anterior abdominal wall may be described as follows: It is a flat musculofascial structure consisting of two plates on either side of, and fused at the midline (linea alba). Each plate is composed of three laminated superimposed muscles of which the external oblique is passive and the internal oblique and transversalis muscles are active in hernia prevention, and therefore will be the muscles considered. Each musculofascial plate may be divided into two major divisions, a medial and a lateral, united by a curved fascial condensation or reinforcement—the linea semilunaris. The latter is the lateral demarcation of the rectus abdominis sheath and extends from the costal margin to the lateral aspect of the pubic bone. Each division is partly muscular and partly fascial or aponeurotic with a

maximum of muscle and a minimum of fascia. Muscle arches, consisting of superimposed internal oblique and transversalis muscle fibers, are found in the caudal part of each division. From the concave edge of these muscle arches attenuated fasciae are prolonged to attachment on the coxal bone and inguinal ligament, these are the result of the transformation of muscle into fascia due to growth tension of the laminated superimposed muscles. The medial pillars of these two arches seemingly fuse with the caudal extremity of the fascial reinforcement (the linea semilunaris) to form a musculoaponeurotic structure, the conjoined tendon, for insertion into the lateral aspect of the pubic bone. The lateral pillars of the arches are inserted respectively into the inguinal ligament (iliopubic line), to the midline (symphysis pubis), and buttressed by an intermediate pier of support at the lateral aspect of the pubic bone, the conjoined tendon. Filling the areas of attenuated fasciae are inserted laterally the spermatic funiculus and medially the rectus abdominis muscle. The arches of muscle are of such size that a minimal muscular contraction will cause the fibers of the muscles (internal oblique and transversalis) to hug the inserted structures and obliterate the arch areas. It now becomes evident why an elastic, muscular anterior abdominal wall, which by its own minimal contraction obliterates the seeming openings, can so successfully oppose intra-abdominal pressure and make viscus protrusion improbable, if not impossible.

Variations of the average pattern may be found in each component of the abdominal wall; these variations influence the coördination of its component parts and their potentiality for hernia prevention. The reasons for the small number of herniae generally found where the areas of muscular deficiency are greater than average, is the presence of a minimal degree of variation in other components of the wall. This and the ability to effect a shift or coördinated interplay of the whole wall, result in the interposition or substitution of one muscular part for another.

Variations of the average anatomic pattern may be found as recessions of all degrees—from the absence of recession (where due to defective tension lines the muscle failed to recede from the inguinal ligament and pubic bone, and to form arches) to recession of such magnitude that the arches almost reach the level of the umbilicus, in the medial divisions, and 1.5 inches above the anterior-superior spine, in the lateral divisions of the abdominal plates, thus making evident the fact that all musculature of the lower anterior wall has been transformed into attenuated fascia. This condition may occur in one or both of the superimposed internal oblique and transversalis muscles and their conjoined tendon component, resulting in either a completely muscular anterior abdominal wall where there is absence of recession, or an anterior abdominal wall (the internal oblique and transversalis muscles) that contains a minimum of muscle fibers and a maximum of fascia with large inelastic arches in its caudal aspect.

While such variations may occur in the abdominal wall, when considered as a unit of two superimposed muscles, they are also found in each component of the internal oblique and transversalis muscles, being present as a variant in one muscle or its parts with average pattern in the other. It should also be noted that the conjoined tendon, being a part of the muscles, will be influenced by the factors affecting the muscles and will, therefore, show all degrees of variation from a maximal muscular to a minimal muscular or fascial structure. The rectus abdominis muscle, being a part of the flat abdominal wall, although a distinct developmental entity, will be influenced by the same growth mechanism that affects the internal oblique and transversalis muscles and will, therefore, show the same types of variation. The lower part of the rectus abdominis muscle, due to the strain, will be muscular or

fascial to a greater or less degree, depending on the stress put upon its musculature after completion of contact with the pubic bone (14 mm., 7–8 week embryo), and will be manifested as short, bulky, muscular and long, attenuated and tendinous insertions.

These insertions, located in areas of attenuation of the anterior abdominal wall that are greater than average, will influence the potentiality for hernia in direct proportion to the amount of muscle or fascial content found in the insertion, and will affect its ability to substitute for the absence of musculature in the areas of deficiency of the abdominal wall plate. The more muscle fibers present in the lower rectus abdominis muscle, the greater its ability to contract and increase its diameter, the more effective it becomes as an aid to the protective mechanism of the anterior abdominal wall required in resisting intra-abdominal pressure and hernia formation.

From the foregoing, it becomes apparent that herniation or viscus protrusion is primarily dependent on the variations of the average pattern and upon distortion of the tension lines of the anterior abdominal wall. The amount of variation may be divided arbitrarily into three groups for the purpose of discussion. The variations range from 1 per cent to that degree of maximal variation where there is entire absence of muscle fibers in the anterior abdominal wall below the umbilicus, which may be considered to be 100 per cent variation.

In group A belong those cases which may be considered as being concerned mainly with failure of the pressure-resisting function of the anterior abdominal wall. An efficient pressure-resisting body wall is one in which, though there be present any degree of structural variation in its component parts, acts so efficiently in the usual routine activity of the individual, that it is able to coördinate them into a unit of 100 per cent competency in resisting intra-abdominal pressure and preventing protrusion of a viscus. In these cases hernia may not occur, except in the presence of certain conditions that impair efficiency and act simultaneously. These certain conditions are (1) a flexed trunk which relaxes the abdominal wall musculature and makes maximum contraction impossible; (2) sudden increase in intra-abdominal pressure; and (3) the aid given by the presence of a peritoneal sac. In the modus operandi of hernia formation, the intra-abdominal pressure forces a viscus to push aside the inefficiently contracted muscle and to appear externally as a protrusion or hernia. The above may be considered as applying to both the congenital and the acquired types of viscus protrusion.

In the so-called congenital type, the partially or wholly unobliterated peritoneal sac only influences the rapidity and extent of the protrusion beyond the anterior abdominal wall. In the acquired type, the formation of the sac is governed by a continuous operation of factors of strain with only the inherent inelasticity of the peritoneum to oppose it.

The treatment of this group where the musculature is generally efficient with only occasional lapses of efficiency, is simple reduction by taxis, rest in bed to allow the stretched and traumatized muscles to recover from the unusual stretching of the fibers, to be followed by muscle training, such as gymnastics. Individuals of this group may continue throughout life without a repetition of the primary occurrence. Industry recognized this group many years ago and provided loading platforms for its burden carriers. This group does not need routine operative interference, except in the acquired type, in which type, injection, or any nondistorting operation is effective as a cure. This group has no recurrences, except those due to infection or improper suturing. Recurrences are generally indirect inguinal herniae, except where the suturing causes marked distortion of the conjoined tendon and enlargement of the middle arch, in which case the recurrences will appear as direct herniae.

In group B belong those cases in which the musculature is of such degree of variation that even in maximum contraction of

the anterior abdominal wall there is no obliteration of the deficiency arches of the internal oblique and transversalis muscles, and in which the structures may not be reconstructed without an amount of distortion of the conjoined tendon, thus impairing the maintenance of the lines of tension of the abdominal musculature. It is in this group that recurrences generally occur in the middle arch, as direct herniae, because changes in position of the conjoined tendon, relative to the other component parts of the abdominal wall result in the enlargement of the middle arch, and greater functional and structural inefficiency of the anterior abdominal wall.

In group C belong those cases which have very little or no muscular fibers in the anterior abdominal wall below the level of a line drawn between the anterior superior spines. Attempting to repair this group without anatomic structures other than those of the abdominal wall, will distort the conjoined tendon and give recurrence in the middle arch—direct herniae. In this group the percentage of recurrences will approximate 100 per cent irrespective of any maneuvers made. Use of fascial flaps with some external support, such as a belt, may prove partially successful.

I have refrained from recommending any specific surgical procedure because it is my belief that further study will develop criteria of evaluation of the various types and will lead to specific treatment for each anatomic type. Routine injection treatment I believe to be a transient fad rather than a constructive maneuver for prevention of herniae, because it fails to consider the very evident fact that scar tissue can never replace elastic muscle in the function of pressure resistance. An adequate and accurate follow-up over a period of time will either cause it to be discarded or limit its use to a very small group of selected cases of the A group of anatomic variations.

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TRANSURETHRAL RESECTION FOR CANCER OF THE PROSTATE*

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INTRODUCTION

THE dire outlook and frequent occurrence of cancer of the prostate make it an unhappy topic for discussion. There are several reasons for the poor prognosis. The tumor itself causes no symptoms; they are due to encroachment upon the urethra, to extension into adjacent structures, or to metastasis. Because the cancer usually grows slowly, symptoms appear late in its course. Chwalla had two patients who lived seven and eight years respectively after cystostomy.

Two other factors operate to defer the onset of obstruction to urination; slow growth of the tumor permits the detrusor to hypertrophy and to compensate for the obstruction until it is quite advanced; and carcinoma of the prostate usually arises in the posterior lobe of the gland, at a relatively great distance from the urethral lumen. (Moore found that 73.7 per cent originated in the posterior, 14.8 in the lateral, and 8.8 in the anterior lobes. None had their origin in the median lobe.) Moreover, the symptoms of carcinoma of the prostate have the same age incidence as and at first are indistinguishable from those of benign hypertrophy; patients are likely to regard them as the inevitable accompaniment of advancing years and to ignore them until they become intolerable or until pain from metastasis appears. They are therefore likely to consult the physician late.

Because of the slow growth of the tumor, the late appearance of difficult urination, and procrastination by the patient, local extension and metastasis are likely to be found when he is first examined. Thus Barringer found the tumor apparently confined within the prostatic capsule in but fourteen of 351 cases (4.5 per cent), and Colston has stated that Young found but thirty-six of 1,040 cases (3.4 per cent) suited for radical operation.

Moreover, clinical evidence of metastasis to bone was found by Ferguson in 30 per cent of his cases, and by Bumpus in 24.3 per cent of those patients in whom *x*-rays were made when they were first seen. Also, Ferguson discovered perineural cancerous infiltrations in 52 per cent of patients coming to autopsy; Graves, Warren, and Harris found them in all.

INCIDENCE

The problem is made more serious by the frequency of the disease. It is variously estimated as causing: 20 per cent of all obstructive lesions of the prostate (Young); 0.6 per cent of all deaths, and 4 per cent of all cancer deaths in the male (Caulk). Prostatic carcinoma was found in 14 per cent of 292 consecutive autopsies in the male by Rich; in 21 per cent of all autopsies on males past 41 by Moore; and in 23 per cent of necropsies on patients past 70 by Muir.

From these figures the seriousness of the problem is apparent. Young has stated that the disease is on the increase, and Duff found that the death rate from carcinoma of the prostate among the male industrial policyholders of the Metropolitan Life Insurance Company increased from 0.8 per 100,000 in 1917 to 3.7 per 100,000 in 1928. It is not clear whether this is a real increase or an apparent one due to the recent increase in longevity, as well as to the change in attitude toward lesions of the prostate evoked by the development of transurethral resection. In connection with the

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former hypothesis, it is worth noting that the life expectancy from birth of the group of Metropolitan policyholders mentioned above increased from 46.6 years to 60.7 years between 1911 and 1937. This increase in individuals living in the higher age brackets is undoubtedly responsible for a large part of the apparent increase in cancer.

Moreover, the development of resection is also an important factor because it has led to a great increase in the number of patients submitting to operation and has produced an apparent but artificial increase in the incidence of all forms of prostatic obstruction.

DIAGNOSIS

The symptoms of carcinoma are those of any obstructive lesion at the vesical neck until local extension or metastases appear. Prior to that time the diagnosis is made by rectal palpation. When the gland is nodular, stony hard, and fixed, this is simple. When the carcinoma is still an isolated, movable, hard nodule (and this is the only time when there appears to be any chance of cure) definite identification of the nodule as cancer is difficult, and biopsy is indicated. The simplest method is that of aspiration through a needle inserted via the perineum. While Keyes and Ferguson have secured positive diagnoses by this method in 86 per cent, its satisfactory use requires a pathologist with considerable experience in making diagnoses from minute fragments of tissue. The percentage of accuracy in most hands will probably fall far below that level.

Tissue may also be secured with the prostatic punch or resectoscope, but this method is least useful when most needed, i.e., in the presence of a small nodule in the posterior lobe, when even an extensive resection will yield only the benign tissue which lies between the lumen of the urethra and the nodule.

The presence of osteoblastic metastases in bone is diagnostic, but of hopeless import; the same is true of the presence of metastatic cancer in removed lymph nodes.

With all these measures available, the incidence of error ought to be low in the hands of the careful observer, especially if routine sections are made of all material removed at operation in order to detect the occasional carcinoma which cannot be palpated because it is surrounded by benign hypertrophy.

TREATMENT

As is evident from the discussion of prognosis, treatment is usually ineffective as far as cure is concerned. Factors already discussed usually postpone the discovery of cancer of the prostate until too late for complete removal. Nevertheless, a good deal in the way of palliation can be accomplished by thoughtful treatment. The methods in general use may be classified as follows:

A. Curative:
1. Radical prostatectomy.
2. Conservative prostatectomy (enucleation of "concealed" cancer).

B. Palliative:
1. Diversion of the urine.
2. Surgical removal of the obstructing tissue.
3. Irradiation.
4. Combinations.

Radical prostatectomy is the only method which offers any hope of cure. While Marion has performed the operation suprapubically, the greater risk inherent in this exposure and the practical impossibility of exposing the posterior surface of the prostate for biopsy, make the perineal approach much more satisfactory. Radical perineal prostatectomy, despite a mortality of 11 per cent and considerable risk of incontinence, offers the chief hope of cure in prostatic cancer. Unfortunately, the low rate of operability (3.43 per cent in Colston-Young's series) makes the operation inapplicable to most cases. While Young has had 50 per cent of five-year cures and freedom from recurrent obstruction in the remainder, this 3.43 per cent operability

reduces the percentage of cures from 50 per cent of operable cases to 1.71 per cent of all cases, a situation remediable only by earlier diagnosis. Smith has had essentially the same results as Young.

Enucleation of a cancer concealed and localized within a spheroid of benign hypertrophy has been enthusiastically proclaimed of late by the opponents of transurethral resection. They declare that the widespread use of the latter has deprived many patients of their chance of cure—a serious indictment of the transurethral operation until one considers all the facts. Only about 8 per cent of cancers of the prostate (twenty-seven of 325 cases of von Illyes), or about 1.6 per cent of obstructive lesions at the vesical neck are concealed within spheroids of benign hypertrophy. In ninety-six cases of concealed cancer assembled from reports by Cunningham, Hirsch and Schmidt, von Illyes, and Bugbee there were twenty-five (26 per cent) of two to five-year cures. Setting the incidence of concealed cancer at 1.6 per cent of all obstructions at the vesical neck, this means that complete replacement of enucleation of the prostate by transurethral resection would lead to the loss of an opportunity for cure of concealed cancer in $\frac{4}{10}$ of 1 per cent (0.26×0.016) of the patients —a loss far outweighed by the lower operative mortality of the transurethral operation.

Diversion of the urine is unsatisfactory. Catheterization leads to an infected, irritable bladder which makes the passage of the catheter painful and requires it frequently. Inlying catheters are notoriously difficult to manage without continuous, expert supervision. Suprapubic cystostomy is more comfortable, but the necessary apparatus causes a great deal of inconvenience and requires special care. Bumpus in 1924 found that the postoperative life averaged twenty-four months with 5 per cent of five-year survivals.

Irradiation is admittedly palliative. High voltage *x*-ray is of value chiefly in relieving pain and in augmenting the effect of radium or radon. Dolan has recently canvassed sixty-three urologists concerning cancer of the prostate; none of them had had a ten-year cure from irradiation; several had had five-year cures; Caulk has never seen a cure, and Barringer estimates that about 10 per cent of prostatic cancers can be controlled for five or more years by a combination of interstitial irradiation (radon) with high voltage *x*-ray therapy.

Transurethral resection is too recent in development to permit an accurate determination of end results, although many discussions of the operation refer with satisfaction to its use in prostatic cancer. Stirling canvassed sixty urologists in 1934 and found that forty-two favored the application of the operation, with or without supplementary irradiation, to cancer, while twelve favored radical perineal prostatectomy but deplored its infrequent applicability.

Bugbee has reported fifty-two cases of prostatic cancer treated by transurethral resection without an operative death. Nine had died of cancer and three from heart disease from twelve to forty-four months after operation, and forty were living from one to forty-eight months with satisfactory micturition. Three had required reoperation.

Jacobs used the operation in fifteen cases with one operative death. Four had died of cancer from three to twenty months after operation, three were not relieved and required cystostomy, and seven were living without obstruction for one to thirty-three months.

Caulk was able to follow 129 cases treated with his cautery punch. Obstruction was relieved in 77 per cent. In 30 per cent life continued three years, 18 per cent four years, 5 per cent seven years, and one patient was living fifteen years with signs of cancer.

Thompson and Emmett have reported the results of the punch operation in 107 cases of prostatic carcinoma. There was one operative death (0.9 per cent). Twenty-four patients died during the first year following

operation, and twenty-seven more during the ensuing ten years. Eleven required reoperation for recurrent obstruction after varying intervals, and fifty-six were living after six to forty-eight months.

CASE REPORTS

The material consists of all cases of carcinoma of the prostate treated by transurethral resection at the University Hospital, Minneapolis from April, 1930 to December 31, 1936. At least one year had elapsed following operation in the last case when this study was begun.

During this period the diagnosis of carcinoma of the prostate was made 275 times. One hundred two patients were treated by transurethral resection with or without supplementary irradiation with interstitial radon and *x*-ray; 112 received irradiation only, twenty-nine had prostatectomy,* of whom twenty-two were also irradiated; eleven had cystostomy,* of whom eight were irradiated; three had radical perineal prostatectomy; and eighteen, were, for a variety of reasons, not treated at all.

Thus transurethral resection was employed in 37.1 per cent of the cases in which the diagnosis of cancer was made. It was used only in the presence of troublesome obstruction to urination. The average age of the patients was 69.6 years; the average residual urine was 440 c.c., and the average amount of tissue removed was 13.1 Gm., the extremes being 1 and 66 Gm. The operative mortality was 1.9 per cent. Demonstrable metastases to bone were visible in 19.6 per cent of the patients when first seen, the lumbar spine and pelvis having been *x*-rayed in all.

It was intended in all cases to relieve the obstruction with the Stern-McCarthy resectoscope, and six weeks later to irradiate the prostate. In approximately half the cases irradiated, radon was inserted through the intact perineum into the prostate and was followed at once by a course of high voltage *x*-ray therapy by a modification of Coutard's method. In the other half of those irradiated the *x*-ray therapy was started six weeks after the operation and radon was implanted at its conclusion. The average dose of radon employed was 30 millicuries in gold implants with walls 0.3 mm. thick and containing 1 to 2 millicuries each.

The object of allowing six weeks to elapse between operation and irradiation was to obviate the untoward reactions which followed simultaneous operation and implantation of radon in my early experience.

Thus it was intended to treat all of this group of 102 patients by the same method, i.e., there was no deliberate selection of one patient for transurethral resection alone, another for operation plus radon, etc. However, thirty-five patients failed to return for irradiation, fourteen came back for radon but not for *x*-ray; nine returned for *x*-ray but not for radon; and forty-four had both. There is thus an opportunity, limited by the small size of each series, to compare operation alone with operation plus radon, plus *x*-ray, and plus both, without the factor of deliberate selection of the patient for a given type of treatment.

The only pleasing features about the results were the low operative mortality (1.9 per cent) and the high percentage of patients relieved of obstruction. In only three patients (3.0 per cent) of those surviving operation was it found impossible to relieve the obstruction to urination by transurethral resection. All three were seen in 1930 and 1931. In two more, naturally not included in the series, resection was thought advisable but could not be done because the instrument could not be inserted.

In one patient the obstruction recurred and was not relieved despite another resection. Cystostomy then had to be done. In another, obstruction recurred but the resectoscope could not be inserted, so that cystostomy was necessary.

* The forty cases treated by partial prostatectomy and by cystostomy were encountered early in the series before the writer felt that he had developed sufficient facility with the resectoscope to permit him to attack larger prostates with it.

In five patients recurrent obstruction necessitated re-resection, which again yielded relief. The shortest interval between operations in this group was four months; the longest thirty months. One of these patients was operated upon first in 1931 and again in 1932 and 1934 for recurrent obstruction.

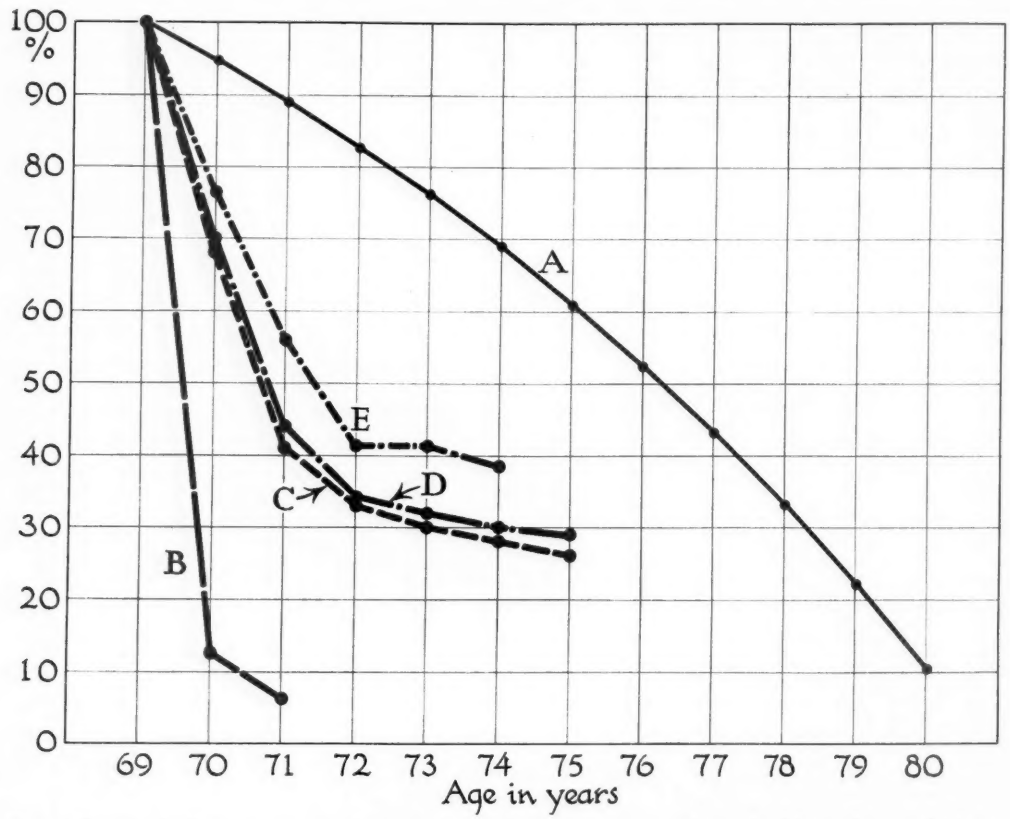

Fig. 1. Survival after treatment of prostatic carcinoma. A, expected survival in male population. B, survival of untreated carcinoma of prostate. C, survival after transurethral resection followed by irradiation. D, survival after transurethral resection with and without irradiation (whole group). E, survival after transurethral resection alone.

The operation achieves the same results as partial prostatectomy or the enucleation of a coexisting benign hypertrophy with a shorter hospital stay and a lower risk. Prostatectomy involves an average stay of fourteen days before and thirty days after operation (Swan and Mintz); that for resection is much shorter; Thompson has been able to omit preoperative drainage entirely in 60 per cent; the total hospital stay from admission to discharge for out of town residents in my experience averaged seventeen days in 400 resections.

A lower mortality is a powerful argument for any palliative operation. Colston has reported 250 partial perineal prostatectomies for cancer with an operative mortality of 6.9 per cent which is probably far lower than that of partial suprapubic prostatectomy. One can probably anticipate a mortality of less than 2 per cent from transurethral resection (below 1 per cent—Thompson, Caulk).

Moreover, the end results do not appear to favor partial prostatectomy, since Colston found the average postoperative survival to be twenty-five and Bumpus thirty months after the perineal and suprapubic operations, respectively. However, there are not yet enough data available to ascertain the average survival after resection. Its lower mortality, shorter hospitalization, and reduced discomfort doubtless leads to its application to much poorer

risks and may thus shorten the average postoperative survival.

RESULTS

As may be seen from Table 1, of the thirty-five patients treated by transurethral resection, the thirty-four who were followed had an average postoperative life of twenty months, including the ten (29.5 per cent) still living after an average of 33.09 months; all seven of those requiring reoperation were in this group.

Among the ten survivors, six, or 60 per cent, were symptom-free from eighteen to sixty-five months. The remaining four have nocturia varying from three to eight times without symptoms of obstruction, from sixteen to seventy-three months after operation.

The thirteen followed patients of the fourteen treated by resection and interstitial radon lived an average of 16.5 months, including the four (30.8 per cent) still living an average of 34.7 months. Of the four survivors, one (25 per cent) has been well twenty-six months. Of the remaining three, one complains of frequency without obstruction at sixteen months, and two have nocturia three times with slight straining at thirty-nine and fifty-eight months.

Of the nine receiving resection and *x*-ray therapy, the eight followed patients lived an average of 16.5 months, including the two survivors who are living thirty-one and thirty-four months. One has nocturia three times without obstruction at thirty-one months, and the other is moribund with pain but without retention at thirty-four months.

In the forty-four receiving resection, radon and *x*-ray, there was an average survival among the forty-two followed of 20.4 months, including the six (14.5 per cent) still living an average of 36.2 months. Of these, two (33 per cent) are well twenty-two and thirty-two months after operation. Of the remaining three, two have nocturia six to eight times; the other is troubled by straining.

Figure 1 shows the comparative effect of the various types of treatment upon the mortality of the patients in terms of the percentage dying during each successive year following treatment. The top line represents the expected deaths in the male population of the United States (Dublin and Lotka). The bottom line represents a group of eighteen untreated patients. It may be seen that mortality of the disease is reduced by treatment, and that the addition of irradiation to transurethral resection had no very significant influence upon mortality. It should be remembered that the curve makes no allowance for the reduced rate of recurrent obstruction which follows irradiation, nor for the additional comfort conferred upon those with pain.

Thus if it is permissible to draw conclusions from such small groups of cases, one may say that urinary retention from prostatic carcinoma can be relieved in 97.1 per cent by transurethral resection; the duration of life thereafter is not materially increased by postoperative irradiation with radon, with *x*-ray, or with both. The tendency for obstruction to recur is lessened by irradiation, but the highest percentage of symptom-free survivors follows operation not supplemented by irradiation. It should be noted, however, that *x*-ray therapy has proved most effective in relieving temporarily the pain from perineural infiltration and from metastases to bone, and is therefore more than justified. The tendency of irradiation to cause shrinkage of the prostate when used alone deserves mention, but will not be discussed.

It has been alleged that transurethral resection is unsurgical in that it cuts through cancer without attempting to cure, and that the cut cancerous surface will not heal. These statements are doubtless true; this is of small moment when one considers the gain in comfort without dependence upon apparatus which is thus secured at a relatively small cost in terms of risk and expense.

It is also stated that transurethral resection causes metastases by traumatizing

cancerous tissue. This is probably untrue. Bumpus observed an average postoperative survival of twenty-four months following cystostomy, while the average postoperative survival for this series is 19.45 months, including those still living. This must be modified by the fact that the survival after the onset of symptoms in Bumpus' series was fifty-seven months; in this group it was 56.57 months. In other words, Bumpus' series of 117 cases was composed of private patients who sought treatment earlier and were treated by a method which did not traumatize the cancer itself; their disease ran its course in fifty-seven months after the onset of symptoms. This series is composed of 102 charity patients who received treatment later by a method which did traumatize the cancer; their disease ran its course in 56.5 months after the onset of symptoms. Therefore one may assume that transurethral resection of the cancerous prostate does not provoke early and widespread metastases.

Even if it did, it is not clear that this would contraindicate its use; radical perineal prostatectomy yields but 1.7 per cent of five-year cures when the results are corrected for the percentage of operability; enucleation of concealed cancer yields 26 per cent of two to five-year cures, but correction of these figures for incidence and operability changes the figure to 2 per cent of all prostatic cancers. The rate of five-year survival by transurethral resection is yet to be established; the fact that 24.8 per cent of the followed cases in the writer's series are living an average of thirty-four months suggests that the results will compare favorably with those of the methods mentioned above.

SUMMARY AND CONCLUSIONS

1. A series of 102 cases is presented in which carcinoma of the prostate was treated by transurethral resection, supplemented by irradiation with radon in fourteen instances, with *x*-ray therapy in nine, and with both in forty-four cases.

2. There were two operative deaths (1.9 per cent).

3. Obstruction to urination was relieved in ninety-nine (97 per cent).

4. Recurrent obstruction required reoperation in seven (6.8 per cent), all in the group treated by resection alone.

5. The average duration of life was 56.5 months after the onset of symptoms, and 19.45 months after treatment, including twenty-one patients (24.8 per cent) still living after an average of 34.18 months.

TABLE I

RESULTS OF TRANSURETHRAL RESECTION

Treatment	Number of Cases		Bone Metastases on Admission	Operative Deaths	Average Survival (Dead)			Average Survival (Living)			Average Survival (All)
	Total	Followed			No.	Per Cent	Length of Life (Months)	No.	Per Cent	Length of Life (Months)	Length of Life (Months)
Resection	35	34	6	2	24	70.5	13.5	10	29.5	33.09	20.23
Resection, radon	14	13	7	0	9	69.2	7.78	4	30.8	34.74	16.53
Resection, *x*-ray	9	8	2	0	6	75.0	11.29	2	25.0	32.5	16.59
Resection, radon and *x*-ray	44	42	5	0	36	85.5	18.3	6	14.5	36.2	20.48
Total	102	97 (95%)	20 (19.6%)	2 (1.9%)	73	75.2	13.5	22	24.8	34.18	19.45

Percentages, except of operative mortality, are based on cases followed.

6. Of the twenty-one survivors, nine (9.2 per cent of those followed) are symptom-free after 29.6 months; twelve (12.3 per cent of those followed) have moderate frequency of urination after 37.6 months; three of these have evidence of recurrent obstruction not severe enough to require treatment. That is, 21.5 per cent are living and at least tolerably comfortable three years after operation.

7. The longest symptom-free survival is sixty-five months; the longest survival with symptoms is seventy-three months (both after resection without irradiation).

8. The vast majority of those who died did not suffer from recurrent obstruction.

9. Transurethral resection affords a safe method of relieving the obstruction to urination from carcinoma of the prostate. It offers no prospect of cure, but is a more comfortable substitute for catheterization or cystostomy, and a safer substitute for partial prostatectomy.

10. Irradiation with interstitial radon and *x*-ray does little but reduce the tendency to recurrent obstruction. It does not increase longevity, but *x*-ray therapy will usually relieve temporarily the pain from metastasis or perineural infiltration.

11. Radical perineal prostatectomy actually offers a prospect of cure but has thus far been rendered ineffective by its low rate of applicability.

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SPONDYLARTHRITIS DUE TO POSTURE AND ITS TREATMENT

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THE belief is widespread that, due to the position of the human body, the vertebrae as the carriers of weight are readily subjected to arthritic changes. Since we know, however, that the vertebrae of chickens occasionally also show osteoarthritic involvement, we can disregard all theories that attribute spondylarthritis to the erect posture of human beings. According to some authorities the frequency of spondylarthritis is due to repeated shocks sustained through modern transportation.

The condition is generally regarded as a form of rheumatoid arthritis, mostly of infectious origin, associated with fibrositis of the muscles of the back. These assumptions are responsible for various therapeutic procedures for so-called back pain, lumbago, etc.

A careful check-up showed that spondylarthritis is not a disease of the working class, but apparently runs in certain families. We have *x*-rayed a great number of children whose parents suffered from this condition, and found that the majority showed an hereditary malformation of the epiphyseal ring of the vertebrae. As a result of these changes, uneven ossification of the epiphyseal ring occurs, causing unequal distribution of weight upon the vertebrae and, ultimately, the condition known as kyphosis or scoliosis of the vertebral column.

In view of these facts, corroborated by Scheurman and Kienbock, it is erroneous to assume that kyphosis of juveniles is caused by incorrect posture at school. It is organic insufficiency which causes a discrepancy between the load and carrying capacity of the vertebrae and which finally results in what we call juvenile kyphosis and scoliosis.

It is known that between the vertebral bodies there are discs composed of elastic fibers and that such intervertebral discs are instrumental in transmitting and balancing the pressure of weight from one vertebral body to the other. The fact has been established that these discs, due to deformity resulting from a fracture of the vertebrae for instance, resume their original form upon elimination of pressure.

It may be of interest to note that the intervertebral discs of the cervical spine have a capacity of sustaining 155 pounds of weight; those of the dorsal, 215; and those of the lumbar, 410 pounds. It has further been established that the height of an average person is 16 mm. less in the evening as compared with the morning—this fact being determined by compression of the intervertebral discs.

It is evident, therefore, that as long as the intervertebral discs preserve their elastic properties, no definite changes in the bony structure will occur on the side of greater pressure, as occurs in kyphosis and scoliosis. However, as soon as the elasticity is diminished, induration of the disc edges set in, with a tendency toward proliferation in the defective areas of the vertebral bone. Such changes, in conjunction with abnormal distribution of weight due to posture, cause a widening of the joint capsules, and hence a loosening of the intervertebral articulations. The process of repair soon begins in such loosely connected joints, and a small bony proliferation is first observed at the contiguous edges of the vertebrae. The proliferation of bone as observed in osteoarthritis is consequently nothing but a process of reparation, with the ultimate tightening of intra-articular connections through bony bridges. The early recognition of initial changes therefore is of utmost importance; and the detection of minor nodules revealed by *x*-ray examination should be carefully

considered even in the absence of subjective complaints.

In view of the foregoing facts, we definitely disregard the concept of toxic infectious origin of spondylarthritis, except in cases of polyarthritis and those of tuberculous or typhoid origin.

As the process of progressive destruction is generally unaccompanied by either pain or discomfort, even in the late stages in the presence of *x*-ray evidence of bony bridges, the patient remains skeptical as far as his relation to the disease is concerned.

Early diagnosis is of utmost importance, and we therefore believe that all cases of scoliosis in young persons should be subjected to *x*-ray examination. In the majority of these cases no definite changes of bone will be noted. It should be borne in mind that proliferation of the edge of the intervertebral disc and the change in the width of the intervertebral spaces are the first signs of the onset of spondylarthritis. Over a long period we have made 1,652 *x*-ray examinations of spines in adolescents in which we were suspicious of such changes. Over 865 of this number were advised to report every year; the others did not show any appreciable *x*-ray findings. However, due to the fact that *x*-ray pictures could only be taken in two dimensions (anteroposterior and lateral), there still remains the possibility that some change might have been present. Only stereoscopic *x*-ray pictures could definitely exclude such possibilities.

TREATMENT

During the early stages of this affection, attention is chiefly directed toward the correction of posture through exercise, mainly creeping, and the strengthening of the soft connective tissue of the vertebrae. Realizing that arthritic changes in the form of ultimate bridging is but a process of repair based upon modification of loosened articulations, we have successfully employed injections of autogenous blood, administered in the joint capsules in a fan-like fashion, the organization of the blood content resulting in the tightening of the capsules. Local hyperemia and vitamin administration are likewise essential.

Case I. A girl 12 years of age complained of a tired feeling in her back, associated with a sensation of cold. Objective findings were slight scoliosis of the upper dorsal vertebrae with marked tenderness upon pressure and atrophy of the muscles of the back. *X*-ray examination showed scoliosis of the second to the eighth dorsal vertebrae, with convexity to the right, but no evidence of bony changes. The intervertebral spaces between the third, fourth, fifth and sixth dorsal vertebrae were definitely diminished. Stimulation of the muscles and active exercise were advised. The patient was under observation for five years, and had no complaint during this time.

Case II. A young woman, 18 years of age, with amenorrhea, was subject to frequent colds, usually culminating in very definite pain around the chest and back. No muscle atrophy was present, but there was very definite scoliosis of the dorsal vertebrae, with limitation of motility of the entire dorsal spine. *X*-ray examination showed the fifth, sixth, seventh, eighth and ninth dorsal vertebrae markedly changed in bony structure, with slight lipping. Corrective exercises and routine treatment alleviated the pain and discomfort. In all probability, however, bony bridging will take place within a few years, the changes having been too far advanced for preventive measures.

Case III. Male patient seventeen years of age complained of being easily worn out and tired. Muscles of the back showed definite atrophy and slight scoliosis of dorsal spine. *X*-ray examination showed kyphoscoliosis of the dorsal vertebrae. There was a definite narrowing of the intervertebral spaces of the entire dorsal and lumbar area. In this case the intervertebral disks had lost their elasticity. Three years later, after corrective exercises and support, *x*-ray examination revealed definite improvement.

The following three cases typify the late stages of spondylarthritis:

Case IV. A male patient, 63 years of age, a porter, generally carried loads of 200 to 250 pounds on his shoulder, with no complaint of pain. This patient slipped and fell on his buttocks. The fall was followed by pain in the left sciatic nerve. The lumbar spine was stiff and painful on pressure. *X*-ray examination

revealed spondylarthritis and definite changes in the structure and shape of the bone. The third lumbar vertebra appeared completely compressed and bony bridging was evident throughout the lumbar vertebrae.

Case v. A male patient of 60 years, a broker, complained of spastic pain in both legs for two years. He had no recollection of having had any accident or previous pain. Complete stiffness of the dorsal spinal and lumbar vertebrae was present. *X*-ray examination showed definite changes in the shape and structure of the tenth, eleventh and twelfth dorsal vertebrae, and a wedge-shaped deformity of the twelfth vertebrae. The lumbar vertebrae showed spondylarthritis with bony bridging.

Case vi. A man 60 years of age, who was occupied in the unloading of trucks, had no previous history of any diseases. Two months previous to examination the patient started to complain of pain in the back, which developed shortly after a sore throat. There was definite immobilization of the dorsal vertebrae, and pain on pressure over this area. *X*-ray examination showed fusion of the vertebral bodies, the vertebral arches missing, and the vertebral canal open. A diagnosis of spina bifida occulta was made.

These and many similar cases show a wide discrepancy between objective and clinical findings. Although patients denied the occurrence of pain, it may be assumed with impunity that, within these long periods, some rheumatoid pain was present at one time or another. It may be of interest to add that precordial and abdominal pain may be caused by irritation of the roots of their respective segments, which may be traced back to arthritic changes in the vertebrae. This type of case deserves special interest, in view of the fact that various manipulations of the spinal column have cleared up symptoms which did not yield to medical treatment.

Case vii. A male patient, 40 years of age, complained for six years of precordial pain associated with palpitation. Electrocardiographic findings of the heart were negative. The patient fell while skating and injured his back. *X*-ray examination of the spinal column revealed no injury, but showed bony bridging of most of upper dorsal vertebrae. The changes between the fifth and sixth dorsal vertebrae were especially marked and showed evidence of osteoporosis and almost complete lack of the intervertebral space. Orthopedic support and local treatment have almost completely cleared up the cardiac symptoms.

Case viii. A man, 51 years of age, complained of pain in the abdomen, especially in the evening. *X*-rays of the intestines showed no changes. The patient was put on various diets, without result. Pain persisted for seven years and gradually became worse. After an automobile accident, the patient had contusions of the back. At this time he complained of severe pain radiating from the lumbar region into both legs. It is interesting to note that the abdominal pains almost entirely ceased after the automobile accident.

Examination revealed complete stiffness of the spine beginning about the sixth dorsal vertebra. *X*-rays showed spondylarthritis of the dorsal spine beginning at the seventh vertebra, and similar changes between the first, second, third and fourth lumbar vertebrae. There was marked lipping of the seventh, eighth, ninth and tenth dorsal vertebrae. The *x*-rays further revealed ptosis of the stomach, which had apparently developed secondarily. Orthopedic support and local treatment have alleviated pain. The patient was observed over a period of three years.

Case ix. A woman, 30 years of age, complained of general weakness for years. Posture had been poor since childhood. For six months the patient had complained of paresthesia in both hands, associated with numbness of the fingers. Elevation of the arms relieved the paresthesia. Marked scoliosis of the upper dorsal spine was associated with pain on pressure over this area. *X*-ray examination revealed slight bony lipping of the third, fourth, sixth and seventh vertebrae and distinct scoliosis of the upper dorsal spine. Local treatment of the cervical plexus alleviated patient's complaint.

Bony proliferation causes a venous hyperemia in the intervertebral venous plexus, resulting in chronic irritation of the root of the nerves in the affected area. This condition produces a point of minor resistance and, therefore, any focal infection may bring about acute inflammation.

It has been our experience that even the gravest forms of spondylarthritis may per-

sist for decades, without any symptoms. Major symptoms invariably develop in consequence of foci or trauma, and present a difficult problem. The symptoms in such cases range from local back pain to referred pain along such nerves whose roots might be affected. Consequently various regions such as extremities, abdomen, precardium, etc., may be the site of complaint.

The method of therapeutic procedure is twofold:

1. *Mechanical.* Elimination of pressure to the highest possible degree, through the application of a belt, and orthopedic exercises as well as stimulation of atrophied muscles, to strengthen interarticular connections.

2. *Chemical.* Administration of drugs known as anti-arthritic remedies, which alleviate pain.

As pain in such cases is invariably due to inflammatory processes in the nerve root, it is natural to apply the method of nerve-blocking by injecting the affected areas with large quantities (¼ per cent) of procaine solution. In some cases *x*-ray irradiation has been successfully employed. We have been obtaining more than satisfactory results by infiltrating such areas with animal serum as a foreign protein. For the past year and a half we have also been resorting to the administration (local infiltration) of a preparation consisting of organic sulfur, iodine, and a local anesthetic. Although this preparation has been used for a relatively short period of time, it appears to be of value, and may be administered as an adequate substitute for procaine.

We are of the opinion that major symptoms of spondylarthritis are most satisfactorily treated by the infiltration method. Cases of simple spondylarthritis, on the other hand, are amenable to bee venom therapy. Local hyperemia in the form of baking, diathermy, and short wave have been found useful adjuvants.

SUMMARY

It has been shown that hereditary malformation of the epiphyseal ring of the vertebrae is the determining factor in pathologic juvenile posture. The most frequent form of spondylarthritis develops as a reaction to such postural changes.

The function of the intervertebral disc is described. It is pointed out that as soon as the elastic properties of these discs are diminished, a narrowing of the intervertebral spaces sets in, as the first step toward the development of spondylarthritis. As shown in the case histories, no complaints are usually present at such an early stage. It is, nevertheless, important to administer treatment, in order to prevent loosening of the soft connective tissues. As soon as the capsules of such articulations become loosened, the vertebral column loses its firmness and a proliferation of bone on the edge of the vertebrae occurs, with the tendency to form bony bridges and to produce tight interarticular connections.

Arthritis, and especially spondylarthritis, if not of infectious origin, is therefore regarded as a form of reparation, with a tendency to tighten interarticular connections wherever the joint capsules become loosened.

Therapeutic measures based on such etiology of spondylarthritis are described.

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CASE REPORTS

CONGENITAL ARTERIOVENOUS ANEURYSM OF RIGHT UPPER EXTREMITY*

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ARTERIOVENOUS aneurysm is not a surgical curiosity, having been first accurately described by William Hunter in 1757 (Reid[1]). These cases of congenital arteriovenous anastomoses are so very rare that it is important to report all such cases.

CASE REPORT

The patient, a 28 year old Negro man, was admitted to the Surgical Service of Harlem Hospital on November 6, 1935, complaining of a progressive enlargement of the right hand and arm, which he had noticed for fifteen years. At the age of four he had received a laceration of the volar surface of the right wrist, for which no medical attention was required. Nine years later he first noted a slight enlargement of the right upper extremity, which he thinks began shortly after he cut his right little finger. Since that time the extremity had steadily increased in size, so that the right arm was about twice as large as the left when dependent, but shrank to nearly normal size when raised above the head. The veins of the right hand and arm had grown very large and tortuous. The arm was much warmer than the left and the right hand perspired profusely. Two years before admission the patient suffered a laceration of the distal phalanx of the right fourth finger, since which time this finger had been painful and tender to pressure, and the soft parts of the distal phalanx had atrophied. Since this injury the patient had been unable to make a tight fist with his right hand. During the year before hospitalization he complained of an aching pain in the midportion of the right arm, most noticeable while lying down. The patient's general health had been excellent; he had never suffered any severe constitutional disease, nor had he complained of dyspnea, orthopnea, persistent cough, chest pain or edema of the lower extremities.

Physical examination disclosed a well developed young man appearing in good health. In the suprasternal notch arterial pulsations were visible. The lungs were normal. The heart was not enlarged to percussion; the maximum apex impulse was in the fifth left intercostal space 1 cm. within the midclavicular line. Heart sounds were of good quality, forceful, with regular sinus rhythm, rate 84; no murmurs were audible. The abdomen and reflexes were normal.

There were no abnormalities of the extremities except the right arm. This was longer than the left by 4 cm. The circumference of the forearm was greater than that of the upper. The entire hand, forearm and medial portion of the arm showed a large number of tremendously dilated, tortuous, easily compressible veins, which filled to tenseness when the arm was lowered and almost completely emptied when the arm was raised above the head. There were three small hemispherical subcutaneous, easily compressible masses on the dorsum of the arm and the right chest wall. (Figs. 1 and 2.) There was a 3 cm. hairline scar on the volar surface of the right forearm 2 cm. above the wrist joint. The skin on the palmar surface of the hand was wrinkled longitudinally. There was atrophy of the soft tissues of the distal phalanges of the 4th and 5th fingers. There was a pronounced thrill over the dilated vessels on the volar surface of the forearm, most marked on the radial side 5 cm. above the wrist. A loud to-and-fro murmur was audible at this point, and a single murmur in the upper part of the forearm. Both the thrill

* From the Surgical Service, Harlem Hospital.

and the murmurs disappeared with slight pressure at the point of maximal thrill.

Blood pressure in the right arm was 140/90, in the left 140/100. Oscillometric readings were as follows:

	Wrist	Upper Forearm	Arm
Right	20 plus	20 plus	20 plus
Left	1.0	2.5	3.0

Laboratory examinations showed the following data: Hemoglobin 90 per cent; R.B.C. 4,500,000; W.B.C. 7,200; polynuclears 72 per cent; lymphocytes 25 per cent; mononuclears 3 per cent; urine examination was normal; blood Kahn was strongly positive. *X*-ray of the chest showed slight enlargement of the heart to the left. Electrocardiogram revealed no evidence of myocardial damage. *X*-rays of the arms and hands showed the left to be normal. The bones of the right arm and hand were larger than normal; they showed abnormally large foramina for the nutrient vessels; there was rarefaction of the bones of the hand and arm, with irregular atrophy of all the small bones about the joints. The right fifth metacarpal was smaller than the first. In the bones of the hand there were many "vacuoles," interpreted by the roentgenologist as due to "pressure from varices." *X*-rays of the hand and forearm following injection of the superficial veins of the hand and of the brachial artery just below the elbow with various radiopaque media showed a large number of greatly dilated and tortuous vessels. No definite arteriovenous communication could be demonstrated. Venous pressure in the right midforearm was 280 mm. of water, in the left antecubital fossa 150 mm. Carbon dioxide combining power of blood obtained from the right brachial artery was 37.26 volumes per cent, and of blood from the left cephalic vein 65.02 volumes per cent.

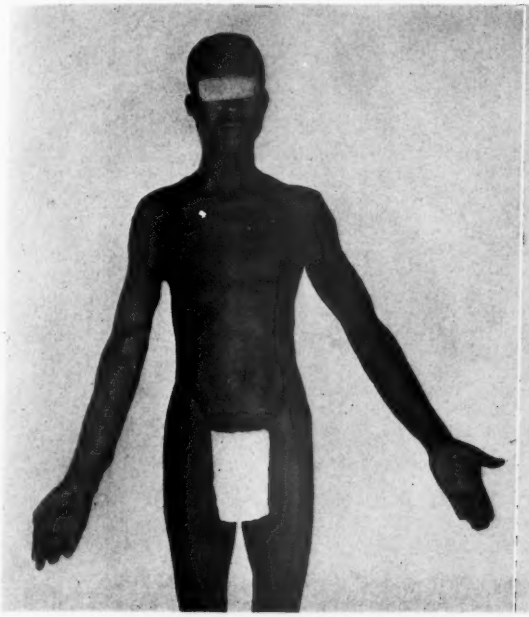

Fig. 1. Note large number of engorged, tortuous superficial vessels in right forearm and arm and increase in length of right arm.

Fig. 2. Note emptying of large superficial blood vessels of right forearm when arm is elevated.

The patient was operated on December 27, 1935, the preoperative diagnosis being arteriovenous aneurysm of the right radial artery. The brachial artery was exposed at the elbow and temporarily ligated with rubber bands. A 10 cm. linear incision over the radial artery just above the wrist exposed many large superficial vessels, which were dissected and ligated. There were numerous adhesions between the tendon sheaths of the flexors and the subcutaneous tissue. A large, thin-walled, pulsating vessel was found at the site of the radial artery; this vessel was followed upwards for 10 cm., becoming larger and more tortuous

proximally, but no abnormal anastomoses were found. It was ligated and a portion excised for section. Incision over the lower part of the ulnar artery revealed similar thin-walled, dilated and tortuous vessels. Microscopic section of the excised vessel showed the structure of a normal artery, but all layers of the wall were thinned. The postoperative course of the patient was entirely uneventful. Healing was by primary intention. Two days after operation no bruit was audible nor thrill palpable. The arm when dependent was much smaller than before operation; the swelling of the vessels was about half as much as formerly. The patient stated that the arm did not feel so heavy as before the operation. He was discharged two weeks after operation markedly improved.

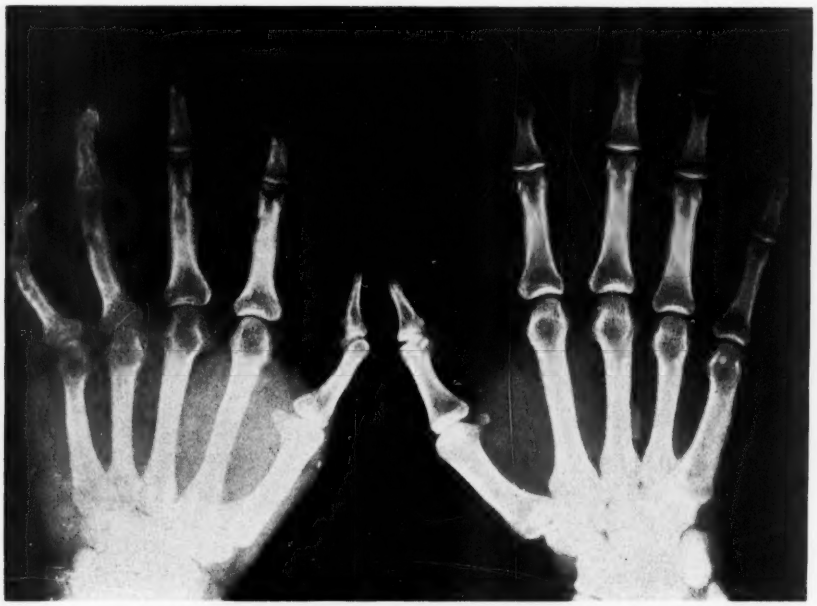

FIG. 3. *X*-ray of hands, showing overgrowth of bones of right hand, mottling and atrophy of distal phalanges.

The patient was readmitted to the hospital on November 15, 1936. At this time he stated that he had done well until four weeks before, all of his symptoms being much improved by the operation. In the previous month, however, he had suffered increasingly severe pain in the tip of the right fourth finger, associated with steadily increasing swelling of the finger. Two weeks prior to admission the nail of the finger had sloughed off. The pain had been so agonizing for two weeks that the patient asked to have the finger amputated if the pain could not be quickly controlled. The size of the arm had not increased since operation. He felt an annoying buzzing sensation throughout the forearm. He complained of dyspnea after moderate exertion, not severe, but steadily progressive in the preceding six months.

Physical examination revealed the following salient points: The heart was enlarged to 1 cm. outside the midclavicular line, the apex impulse being felt in the 6th intercostal space; there was a soft systolic murmur at the apex. The pulse was 90, the blood pressure in both arms 130/90. The right hand was one and a half times as large as the left, the skin dry and wrinkled, and there was a foul ulceration involving the distal phalanx of the fourth finger. There was a well-healed scar over the right radial artery, and no pulsation, thrill or murmur was detected over its course. Over the ulnar side of the forearm, however, extending up to the elbow, there was a pronounced thrill with a loud to-and-fro murmur. There were, as on the first admission, numerous dilated and tortuous veins throughout the forearm, arm, and upper half of the right chest. Several small, soft, hemispherical, subcutaneous and freely movable non-tender masses were present in the arm and right chest wall.

Laboratory data showed: urine normal. Hemoglobin 70 per cent; R.B.C. 3,660,000; W.B.C. 7,600; polynuclears 67 per cent; lymphocytes 25 per cent; mononuclears 8 per

cent. Blood Kahn was 3 plus. Blood chemistry was: creatinine 1.1; urea nitrogen 14.7; sugar 78. *X*-ray of the chest showed the heart to be enlarged to the left and downward, with the lungs clear. *X*-ray of the right hand showed "atrophy of the bones, with narrowing of the joint spaces and numerous erosions throughout, due to arteriovenous aneurysm." (Very similar to *x*-ray on first admission.) In an attempt to localize any abnormal arteriovenous connections in the arm, specimens of blood were taken from the veins of four segments of the extremity, following the technique described by Veal and McCord[2] of the Mayo Clinic. These values were obtained:

	Dorsum of Hand	Lower Half of Forearm	Upper ¼ of Forearm. Lower ¼ of Arm	Middle Half of Arm
CO_2 vols. per cent.....	37.02	36.50	42.02	46.17
O_2 vols. per cent	31.38	30.42	21.41	28.63

These results appear to show the presence of blood nearly arterial in character in the veins of the forearm, thus probably placing some abnormal arteriovenous communication in this area.

Fig. 4. Section from artery in right arm, showing degenerative changes in media.

Operation was performed on December 30, 1936. Having dissected the radial side of the forearm at the first sitting a year previously without finding any evidence of direct arteriovenous communications, we believed that a second operation over the ulnar vessels would be similarly disappointing both as to finding pathology and affording relief to the patient. We felt, too, that a sharp reduction in the supply of arterial blood to the limb would bring about marked subjective relief and would postpone the day when amputation of the arm (which appeared eventually inevitable) would have to be done. Under ether anesthesia the antecubital space was dissected. The subcutaneous tissues were filled with a large number of enormously dilated, tortuous and thin-walled veins, the vena mediana cubiti and the basilic vein being the largest, the former measuring 2 cm. and the latter 1.5 cm. in diameter; no arterial pulsation was noted in these veins. The brachial artery was isolated for a distance of 5 cm.; it appeared somewhat thinner-walled and more friable than normal. No direct arteriovenous communications were encountered. The brachial artery and the vena

mediana cubiti were ligated and a 5 cm. segment of each was resected. In addition, one of the spongy soft tissue masses described above was removed from the subcutaneous tissue over the belly of the triceps muscle, as well as two small sections of the muscle for microscopic examination. The incisions were closed without drainage. Healing was prompt.

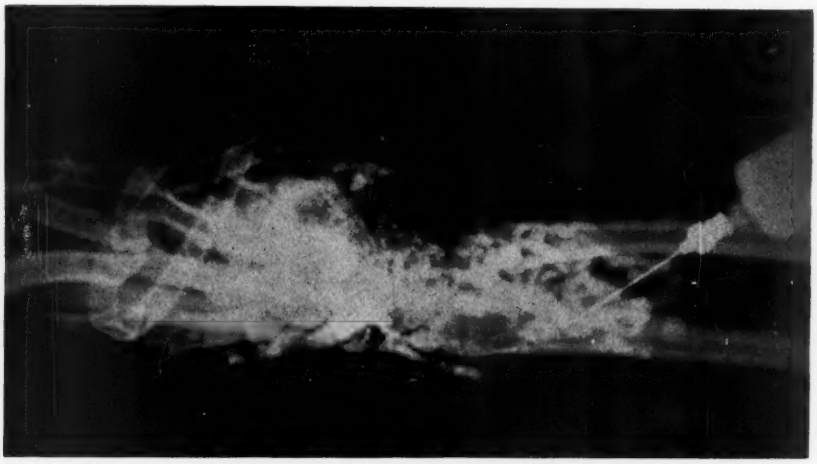

FIG. 5. Roentgenogram after injection of right radial artery with 50 per cent sodium iodide, showing marked increase in vascularity of right forearm and hand.

At no time after operation was any pulsation felt in the arm below the elbow. There was immediate and marked subjective relief, in that the patient had much less pain in the hand and arm, and no longer was troubled by the constant buzzing sensation which had previously been so annoying. On the fifth postoperative day the patient complained of severe steady pain at the tip of the fourth finger, which showed a slight spread of the soft dark slough present on admission. This pain was controlled with small doses of codeine for several days, but two weeks after operation was so intense that he asked to have the finger amputated. At this time there was a further slow spread of gangrene down the fourth finger, as well as small gangrenous spots on the tips of the second and fifth fingers. Amputation of the fingers or hand was not done because it was felt that in the presence of the impaired circulatory status of the limb healing would not take place. On discharge of the patient one month after operation, there had been no further spread of gangrene, and the pain in the hand had completely subsided, so that he felt somewhat improved by operation. We knew, however, that the pathology had not been eradicated, and believed that eventually high amputation of the arm would be necessary as a life-saving measure. This procedure was urged on the patient, but at this time he refused such radical treatment.

Microscopic examination of the specimens removed at the second operation showed (1) a normal brachial artery; (2) an increase in the smooth muscle fibers in the walls of the vena mediana cubiti; (3) normal striated muscle; and (4) the soft tissue mass, designated an arteriovenous angioma. The sections showed tissue composed almost entirely of blood vessels most of whose walls were only one cell thick; a few small vessels with the structure of small arteries and veins were seen. No cells were seen which appeared definitely neoplastic in character.

Following the last discharge from Harlem Hospital, this man suffered increasingly severe pain in the right hand and forearm, and there was a slow spread of gangrene up the hand. In February of 1937 the arm was amputated in an Elizabeth, New Jersey hospital, the amputation being done at the mid-shaft of the humerus. (Unfortunately no pathologic study of the amputated extremity was made.) Relief of all symptoms followed immediately and has continued to the present time. He states that he feels better than at any time in the past four years. All cardiac symptoms have completely disappeared. The amputated stump is completely healed and the patient wears an artificial limb. There are still a few slightly dilated superficial veins in the arm and shoulder, but there is no abnormal arterial pulsation, and no other apparent difference between the

upper halves of the arms. Whether or not the process has been permanently arrested I cannot say at this time; certainly the man is clinically well, eighteen months after amputation.

COMMENT

This case is interesting from several standpoints, first as to diagnosis. The mass removed from the arm showed angiomatous tissue, making it appear likely that the whole pathology was hemangioma of a cavernous type. On the other hand this patient's whole extremity was larger than the left arm; there was increased bone length and size in the forearm and hand. In addition, specimens of blood drawn from veins of the arm more closely approximated normal arterial than normal venous blood in their gas-carrying capacity; this fact would suggest multiple abnormal arteriovenous communications; no such communications, however, were found at either operation. Moreover, the abnormal arterial pulsations and bruits suggest the likelihood of arterial origin of the process. Mont Reid[3] makes this statement: "It seems certain that the impaired circulation in a case of subcutaneous cavernous hemangioma is due to the venous angioma and that, as a result of poor nourishment, the limb fails to develop normally. In this case the capillary bed is probably normal but the large angioma on the venous side of it definitely embarrasses circulation. This is in quite striking contrast to the over-development that may result from cirsoid aneurysms; in cirsoid aneurysms there is an overabundance of arterial blood without any obstruction to venous return."

Hemangiomata of various parts of the body are not rare, being repeatedly described as occurring in the skull, the liver and skeletal muscle. Jenkins and Delaney[4] collected a series of 254 cases of hemangiomata of skeletal muscle. All of these, however, were directly traceable to a definite origin in some particular vein or small group of veins. Most of them were definitely encapsulated tumor masses.

This case, in contradistinction to those described by Delaney, is one presenting a diffuse process involving a whole extremity, and no origin in any one vein, or artery either for that matter, could be found. So diffuse a disorder, if indeed it be an hemangioma, is very rare. Definite proof of the type of lesion is missing because of the failure to dissect and study the amputated arm.

The senior author has performed twelve operations in which the subclavian artery and vein were anastomosed for the relief of aortic aneurysm. This is a modification of Babcock's operation, in which he made an arteriovenous fistula between the common carotid artery and the internal jugular vein. The patients that survived this procedure eventually died of heart failure due to the strain thrown on the heart by the fistula. The clinical picture, however, so completely fits the criteria for diagnosis of arteriovenous aneurysm of congenital origin, that we are justified in considering this case one of congenital arteriovenous aneurysm. Seeger,[5] in an exhaustive treatise on the subject of congenital arteriovenous anastomoses, describes just those findings presented above as diagnostic of congenital arteriovenous aneurysm, namely, hypertrophy of soft tissues and bones, increased oxygen content of venous blood, increased temperature of the skin of the extremity, and venous dilatation.

CONCLUSION

The presence of an arteriovenous fistula demands complete extirpation of the fistula or fistulae, for cure. In some instances it is possible locally to remove the lesion and save a limb. If the pathologic process is too extensive, then amputation is indicated if the patient's life is to be saved.

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DILATED MOBILE CECUM WITH VOLVULUS SIMULATING INTRA-ABDOMINAL CYST

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WHILE numerous studies and case reports of volvulus of the cecum and cecocolon have been published, the writers have seen no case report with roentgenographic and roentgenoscopic findings such as are found in the case herewith reported. Indeed, very few of the case reports are accompanied by illustrations of the Roentgen findings. Most writers concede that volvulus of the cecocolon is dependent on failure of the primitive mesentery of the cecum to become adherent to the posterior peritoneum. This leads to a mobile cecum, the degree of mobility being proportionate to the length of the mesentery. In extreme cases, the ascending mesocolon may be continuous with the mesentery of the small intestine, resulting in the condition known as mesenterium commune. The embryologic defects leading to mobile cecum have been fully discussed by many writers.[1,2,3]

Once present, a mobile cecum is a potential source of volvulus, dependent upon such factors as indiscretion of diet, distention of the cecocolon by gas, excessive exercise, drastic catharsis, and similar mechanical disturbances.

Volvulus occurs mainly through a vertical axis with rotation in a clockwise direction. The resulting symptomatology and pathology depend upon the degree of torsion. If the torsion is less than 180 degrees, the obstruction may be incomplete and the circulation to the cecocolon may not be interfered with excessively. If the torsion is over 180 degrees, the obstruction may be complete and gangrene may result.

Some writers divide their cases into acute and chronic, the latter being more common and generally giving obscure symptoms of intermittent obstruction. The acute cases occur much less frequently (1.15 per cent of all cases of acute intestinal obstruction in Massachusetts General Hospital from 1873 to the present[4]).

The diagnosis of the acute cases is seldom made preoperatively, contributing to a high mortality due to the delayed treatment. Occasionally the diagnosis is made more difficult by complicating factors such as pregnancy.[5] In the chronic cases, a history of recurrent acute attacks of pain and vomiting, relieved without operation, may suggest the diagnosis. There are cases of hypermobile cecum with a range of vertical mobility of more than 1⅓ inches which may give definite clinical symptoms but which cannot be included in this report since they are not associated with volvulus.[3]

CASE REPORT

A white male, 54 years of age, was admitted to hospital October 11, 1937, with the following complaints: (1) nausea and vomiting for three days; (2) no bowel movement for four days; (3) pain through the entire abdomen, particularly the right lower quadrant; and (4) severe bloating and inability to pass gas.

His illness had begun about one week previous but he had been able to go about his usual duties as a farmer until three days before, at which time pain, distention, and nausea became so severe that he could no longer continue. He was unable to sleep at night but got some relief by sitting on the side of the bed and trying to induce vomiting; this caused him to eructate small amounts of gas and relieved the distention, but not the pain.

He stated that he had had similar attacks for more than five years. About three years previous, during such an attack, his case was

diagnosed as acute appendicitis; the surgeon opened his abdomen but closed it at once without even removing the appendix. He did not know what was found at the time of this operation, but within three months he had a similar attack in another city. The hospital authorities of the second city, after communicating with the original surgeon, decided to treat him with enemas and purgatives. Since then he had treated himself in a similar manner; however, this treatment had been getting less satisfactory with each attack. The last two attacks had been extremely severe and the present attack was the most severe of all. He had always been quite constipated and had had to use heavy doses of cathartics almost daily.

Physical examination showed a slender, moderately nourished white male, very critically ill. Head, neck and chest were negative except for slight coarse bronchial breathing. The abdomen was markedly distended. There seemed to be a tumor mass just to the left and slightly superior to the umbilicus which the patient claimed could be slightly reduced by manipulation, resulting in a small amount of transient relief. This entire mass was tender when palpated. There was no absolute point of maximum tenderness, but the entire right lower quadrant of the abdomen revealed no peristalsis.

Laboratory tests showed 4,500,00 red cells with 95 per cent hemoglobin, and 12,700 white cells with 89 per cent neutrophiles, of which 30 per cent were staff forms and 59 segmented. There were 1 per cent basophiles and 10 per cent small lymphocytes. The urine was essentially negative. Blood and cerebrospinal fluid Kahn were negative.

Fig. 1. Barium enema. Note triangular shadow at site of volvulus, simulating ileum.

Fig. 2. Note triangular shadow, described in Figure 1, now leads into a distended cecum.

In Roentgen examination of the colon by enema the barium progressed without obstruction to the colocecal region. The flexures showed no abnormality. There was tenderness over the colocecal region. On gentle pressure, a small amount of barium could be forced into a triangular shaped portion of bowel which was believed to be ileum and which subsequently proved to be the colocecal junction. (Fig. 1.) There was no distention of the coils of the small intestine and it was concluded that the obstruction was probably due to an adhesive band in the colocecal region from the previous operation. The patient was requested to expel the barium and was again fluoroscoped. He then showed a marked distention of a loop of bowel which was thought to be ileum but later proved to be cecum. (Fig. 2.)

Immediate films showed findings similar to those found on fluoroscopy. (Figs. 1 and 2.) Twenty-four hour films showed a large cyst-like

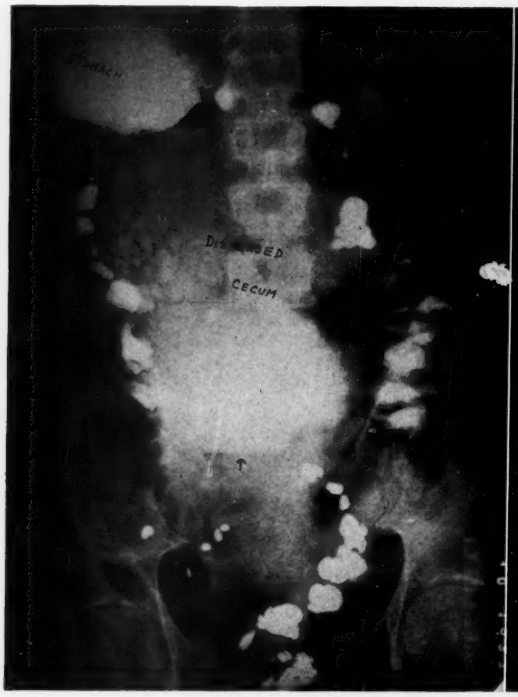

FIG. 3. Twenty-four hours after barium enema. Patient given barium by mouth. Note distended cecum simulating cyst and containing flocculi of barium.

formation lying mainly on the right side of the abdomen and anteriorly. (Figs. 3–6.) There appeared to be a fold in the cyst-like mass and the barium was suspended as flocculi. A small amount of barium given by mouth showed no connection between the stomach and the cyst-like mass. The conclusions from the Roentgen examination were that we were dealing with either an intra-abdominal mesenteric cyst or a dilated bowel due to volvulus.

Medical treatment was not successful. Enemas did not return, and when they were syphoned off only a portion of uncolored returns could be obtained. The administration of prostigmine every two hours for six doses caused the enema to return and considerable flatus was expelled. The tumor mass seemed softer and somewhat reduced in size. However, the condition of the patient was only slightly improved and his pain was still quite marked. A preoperative diagnosis of possible mesenteric cyst was made and operation was performed three days after admission.

The abdomen was opened in the midline 2 inches above and 3 inches below the umbilicus. As soon as the peritoneum was opened the appendix came up into the incision. It showed only slight signs of old inflammatory reaction.

FIG. 4. Lateral view, twenty-four hours after barium enema, showing dilated cecum lying mainly anteriorly.

The cecum to which it was attached was very markedly distended and severely rotated. Three-fourths of this tremendously distended cecum was to the left of the midline incision. Exploration revealed dense adhesions and a band formation across the colocecal junction with definite kinking of the gut. The adhesions were released and a mesentery transplant was sutured over the abraded area. The appendix, which was definitely on the anterior portion of the cecum, was removed incidentally.

Upon his awakening from the anesthetic the patient remarked about the complete relief from pain. The day following operation his condition was good. On the second day cough developed, but there was no distention of the abdomen. On the third day, postoperative lobar pneumonia developed and he died on the afternoon of the following day.

Autopsy Findings. The stomach, duodenum and jejunum showed no significant gross pathology. There was a dilated mobile cecum having a common mesentery with the terminal ileum. There was definite narrowing of the colocecal junction which lay about 1 inch below the iliac crest. At this point there was a

torsion of the bowel in the horizontal axis for about 135 degrees. This narrow twisted portion led into a dilated cecum which showed the cut section was mushy. The kidneys showed some cortical cysts.

Typical lobar pneumonia was noted in

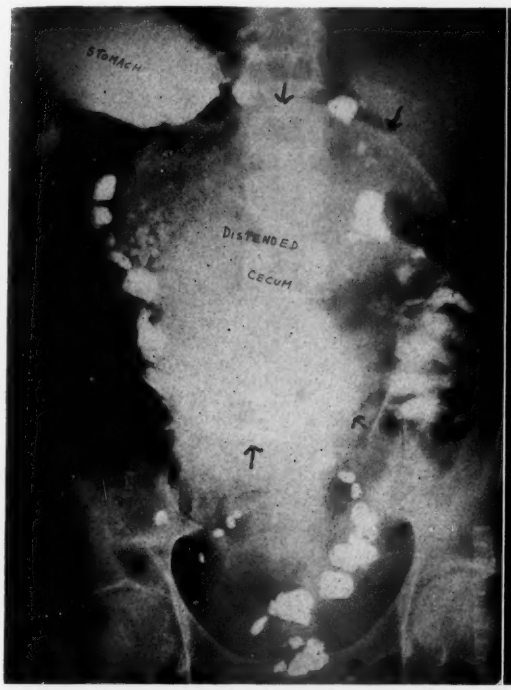

Fig. 5. Anteroposterior view, showing dilated cecum outlined by arrows.

Fig. 6. Six hours after oral barium, showing gastric retention and partial filling of ascending colon. Distended cecum still visible.

numerous holes from the embalmer's trocar. Despite the fact that the cecum had been emptied, it still measured about 7 inches from above downward, but was flattened ventrodorsally. The appendiceal stump lay anteriorly instead of posteriorly due to the rotation of the cecum which was adherent posteriorly to several coils of ileum by a common mesentery. The colocecal junction at the point of torsion showed a thickening of the wall with hemorrhage into the wall. The mucosa was hemorrhagic. The wall of the dilated cecum itself was thin, but the mucosa grossly appeared quite normal. There were some fresh adhesions in the region of the torsion and around the appendiceal stump. The ileocolic valve appeared normal and opened posteriorly. There was no evidence of gangrene of the bowel.

Extensive massive consolidation of both lungs with the exception of the upper lobe of the left lung was noted. There was a thin fibrinous exudate over the leaves of the pleurae.

The liver was enlarged. The heart showed slight atherosclerosis of both coronaries and some dilatation of the right auricle. The spleen was enlarged to about twice normal size and microscopic study of the lungs. The alveoli were filled with red blood cells and polymorphonuclear cells. Occasional alveoli showed rupture of the walls.

Sections made of the dilated portion of the cecum showed only some fragmentation of the muscularis. Sections from the site of torsion showed edema of the submucosa, hemorrhage into the entire wall, some leucocytic infiltration of the wall and a few small abscesses in the submucosa.

SUMMARY

A case of mobile cecum with volvulus which roentgenographically simulated an intra-abdominal cyst, is presented. The history and physical findings suggested acute appendicitis so strongly that the patient had previously been operated on for acute appendicitis. Our Roentgen findings suggested either a large cyst communicating with the cecum, or a dilated mobile cecum. At operation the latter

condition was found. The volvulus and the adhesions (the latter probably being of embryologic origin) were released and free passage through the bowel obtained.

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All patients with crushing injuries or contused lacerations which may be liable to develop gas gangrene should be given a routine injection of both perfringens and tetanus antitoxin.

REGIONAL ILEITIS*

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ALMOST interesting case of regional ileitis came under our observation March 17, 1938. The patient was a poorly nourished, anemic young man, aged 17, 5 feet 8 inches tall, but weighing only 80 pounds. Throughout his life he had been frail, below par, undernourished, and listless. He had always been constipated but never subject to diarrhea. There was no evidence of recent loss of weight. For some weeks past his constipation had become more pronounced and he had noticed what he called "growling" in his abdomen with occasional cramping pains. In the past week the borborygmus had increased.

At our first observation this symptom could not be elicited and but little pain was present on palpation. There was scarcely any resistance or rigidity over the abdomen. There seemed to be no urgent indication for operative intervention. His physician had found on several occasions marked borborygmus and distended coils usual in intestinal block.

When the youth was next seen two days later, this latter finding was quite marked and a diagnosis of intestinal obstruction was made. The location of the obstruction seemed to be in the ileocecal region. Roentgen-ray findings were not illuminating.

At operation on March 20, 1938 the obstruction was found to be produced by a localized thickening of the terminal portion of ileum, the cecum not being involved. This portion of the ileum was bound down to the posterior peritoneum and its walls were thickened throughout all layers, constricting and closing the lumen. The lesion was at first thought tuberculous, since the resemblance to this affection was marked. On closer observation the conclusion that it was a case of regional ileitis was reached.

The patient's condition seemed to preclude an immediate resection unless a lateral anastomosis could be quickly effected. An ileocolostomy between the transverse colon and the ileum was completed. However, on an attempt to free the mass for removal, the anesthetist advised conclusion of the effort and this advice was followed. The patient improved, his convalescence was prompt and in four months he had gained 50 pounds, to 130, was alert, with a rosy complexion and seemed well on the way to recovery.

On July 29, after complaining of some fever, sharp right-sided pain, nausea and vomiting, and physical signs of obstruction, he presented himself for operative relief. Marked tension upon the ileocolostomy was found, sufficient to cause obstruction. The anastomosis was released and after the stomata were closed in the intestinal loops, a temporary ileostomy was made.

Four days later, August 2, 1938, the terminal ileum, the cecum and the proximal third of the ascending colon with the adjacent lymph glands were resected. An end-to-side ileocolostomy was completed by suturing the open colon to a large opening in the side of the ileum, a procedure which seemed advantageous. Closure of the open small bowel was easily accomplished. The ileostomy opening was freed from its attachment to the abdominal wall and its opening was closed after evacuation of its contents by suction.

The involved loop, consisting of the terminal ileum, was thicker, firmer and less mobile than normal. It was mottled, grayish-red and sausage-like and its lumen was completely occluded. The peritoneum showed more change than at the former operation and the group of glands had increased in size and number. Above the affected loop the entire small intestine was much distended and its wall attenuated. The abdominal wound was closed in layers. The affected ileum presented a smooth, somewhat edematous peritoneal surface with some exudate about the mesenteric attachment near the ileocecal valve. On section the muscularis and mucosa were replaced in considerable degree by granulomatous tissue. The latter presented a grayish-white almost homogeneous

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avascular surface very similar to a tuberculous granuloma and a number of writers have mentioned this resemblance, notably Pemberton

Fig. 1. Gross specimen. Case 1. Terminal ileitis.

and others. It was not possible with certainty to differentiate from gross observation, between tuberculous granuloma, sarcoma or chronic regional ileitis. A more thorough study led to the diagnosis of the latter affection.

We had previously observed another most interesting case of regional ileitis of the acute type.

L. W., aged 16, male, white, was hospitalized February 10, 1936, with the history of having been annoyed intermittently with nausea, but no vomiting. During the preceding eight hours he had experienced severe pain confined to the right iliac region which had been of a paroxysmal character, radiating over the right iliac crest. There had not been an evacuation of bowel content for twenty-four hours.

A year before a similar sequence of symptoms occurred, and appendectomy had been done.

The temperature was 101; pulse 110; blood pressure 98/64 diastolic. The abdomen was quite distended, and on auscultation increased peristalsis and borborygmus were detected, regidity was localized to the right iliac region with hyperesthesia. There was no absence of liver dulness.

Leucocytes nunbered 24,000, with 90 per cent polymorphonuclears; 5 per cent lymphocytes and 1 per cent mononuclears. The specific gravity of the urine was 1.022; acid reaction and 1 plus albumin were noted.

A diagnosis of Meckel's diverticulitis with obstruction was made and immediate operation was advised.

Cyclopropane anesthesia afforded excellent relaxation and a right low rectus incision was followed by a free flow of dirty tinged fluid accompanied by fibrin flakes. On endeavoring to deliver the ileum for inspection, in search of a Meckel's diverticulum, it was found that the terminal ileum was indurated in its complete circumference and fixed to the posterior peritoneal wall extending from the ileocecal valve for about 2 inches, with a resultant distention above. An attempt to free the terminal ileum resulted in a gush of intestinal content from a perforation which had evidently been sealed by nature's efforts. An intestinal clamp was placed on the proximal portion of the terminal ileum coincident with delivery. The parietal peritoneum lateral to the cecum was incised, the terminal mesentery of ileum was ligated and divided and 8 inches of terminal ileum and cecum was resected. A modified Mikulicz procedure was used, exteriorizing the free ends of colon and ileum with clamps through a small wound lateral to the incision. Two Penrose drains were introduced and the original incision was closed in the usual manner.

Intestinal decompression was produced by use of a duodenal tube and continuous suction.

Five days postoperatively both clamps were removed from the intestinal stumps with but slight retraction of stomata. A profuse drainage of intestinal content ensued, which was so troublesome to the patient and nursing staff that we decided on the eighth postoperative day to cut the intestinal spur. An angiotribe was introduced into both intestinal limbs and retained for twenty-four hours, after which there was a notable diminution in the fecal drainage. On the twenty-fifth postoperative day the discharge had ceased, and the patient was dismissed as recovered thirty days following operation.

Pathologic Report. There was a thickening of all coats of ileum from the ileocecal valve for about 2 inches, resulting in partial occlusion. The lesion was similar in consistency to a scirrhous carcinoma of the left colon, but more extensive, chronic, granulomatous inflammatory changes (hyperplastic) were noted, with fibrous tissue replacement. No evidence of tuberculosis was present. The diagnosis was chronic benign ileitis.

The literature upon this subject is quite plentiful and comprehensive, but there is as yet no agreement upon the etiology, the pathogenesis, the pathology, or even the clinical description of this form of ileitis.

Most writers hold the view that the cause of regional and also of terminal ileitis is probably bacterial even in the absence of a specific organism. So far no organism has been isolated in a sufficiently large number of cases to be even suspected as the cause. The presence of Streptococcus viridans has been observed by some, but its causative action is not established. Intensive studies have failed to show evidence of tuberculosis as a cause. The same is true of the anaerobic streptococcus studied by Mixter, also of the bacillary causes of dysentery. It has been demonstrated that regional ileitis is not the result of Hodgkin's disease, lymphosarcoma, or other neoplasms. Neither lues nor mycotic fungi have been proved causative. That appendicitis has any direct causal relation does not seem probable, although in some instances appendicitis has preceded this affection. The presence of an appendectomy scar is placed by some among the diagnostic points. The term "intestinal granuloma" has appeared in the literature for many years and has been applied to certain lesions characterized by chronic inflammatory changes arising from different causes.

Charles Combe and William Saunders reported in full detail to the Royal College of Physicians in London, July 4, 1806, the history of the first case of this ailment. Stricture, loss of flesh, abdominal distress, "wind and costiveness" were reported. The pain was intense, the stools were small and in indurated lumps. The patient was markedly emaciated in the last stages. Three distinct constrictions existed and his death evidently occurred from starvation (or inanition). The condition was considered as a benign granuloma.

Fig. 2. Low power photomicrograph in Case 1.

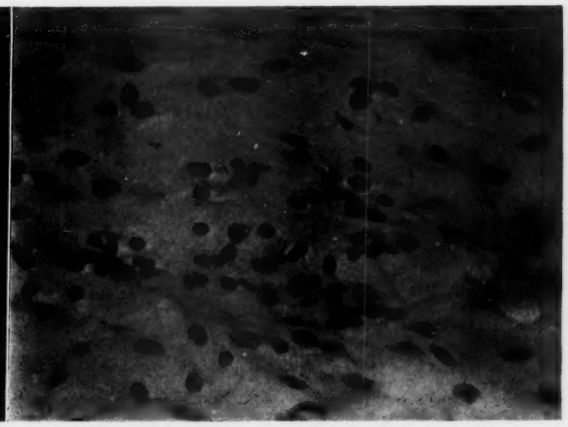

Fig. 3. High power photomicrograph.

It was not until 1828 that Abercrombie made his report. Nothing appeared between these dates. B. G. A. Moynihan's report was made in 1907, Braun's in 1909, and Tietze's in 1910. These writers were able to recognize the lesions as "benign intestinal granuloma" and to differentiate them from carcinomata. Crohn and his colleagues in 1932 first recorded a series of fourteen cases involving the terminal portion of the ileum and gave the name of terminal ileitis to the lesion. In many cases reported the pathologic changes are identical in the cecum with those in the ileum. The same is true of the jejunum. Three cases in that portion of the gut alone, two in the upper ileum and twenty-four in the terminal segment appear in Pemberton and Brown's series of thirty-nine cases. In eight cases more than one loop was involved (included in Sproull's report of 132 cases). Isolated areas of enteritis occur, with healthy mucosa sometimes lying in between ("skip areas") (Barber and Stokes). The concept of Crohn and his confrere that this disease affected only the terminal ileum must in the light of recent

knowledge be revised, since other portions of the intestine, both small and large, have been involved. It therefore seems best to adapt the term "regional ileitis."

PATHOLOGY

The pathology of regional ileitis is better understood than its causation. This is true more particularly of the chronic sclerosing cases as these come to operation and are more often seen by the pathologist. In the earlier and more acute lesions resection is less frequently done. "At this time, the affected portion of the bowel is soggy and edematous and appears hyperemic and blotchy. According to Erb and Farmer the edema may occasionally be so marked as to make the terminal ileum seem a very rigid tube. If the edema is not so severe, the bowel may feel like sponge rubber. Even in the earliest cases, the ulcerative and inflammatory changes may be definite. . . . In the later stages the acuteness subsides somewhat and a more characteristic picture is seen. The oldest portion of the lesion is usually closest to the ileocecal valve. The process extends a variable distance up the bowel and may merge gradually with normal tissue or the transition may be a sudden one. The unopened intestine appears stiff and thick and hose-like, and roughened or granular. . . . As a result of hyperplastic and exudative changes in the submucosal and muscular layers the intestinal wall may be two or three times its normal thickness. On being cut, it appears stiff and white. In the later stages exudation and edema may subside somewhat and fibrotic infiltration become marked. The thickening and contraction of the bowel wall encroaches upon the lumen and results in a gradually increasing stenosis" (Tumen).

The appendix if involved may show the same changes as the segment of the ileum. When the process extends to the colon from the ileum the pathologic process is the same. In our cases the appendix was not involved.

The microscopic picture shows no changes which may be considered as specific. For the most part these are inflammatory, but occasionally the tissue is smooth granular and may resemble a neoplasm or at least a granuloma. Occasionally giant cells are present. The lymphatic glands of the mesentery are congested, swollen and firm, but show nothing specific. The pathologic process is usually progressive but varies much in different cases. In some instances retrogression may occur, with periods of quiescence or even recovery. Ulceration and fistula formation may be seen. It is not possible in many cases to differentiate between intestinal tuberculosis, sarcoma and chronic segmental ileitis by gross study, nor is it always easy on microscopic observation to make a clean-cut differentiation.

ETIOLOGY

Just as the exact pathology is not identical in each case, the causative factor is unknown. It is a most interesting problem to determine why the localizing process tends to infiltration of the intestinal wall and stenosis of its lumen in some cases, while ulceration and fistula formation occur in others, with no definite difference in bacterial flora or other discernible factor. Are there different causative factors in different cases? The thought arises in the inquiring mind whether this affection with its unusual type of development, its enlarged lymphatic glands, ulceration and fistula formation in one, no ulceration in another case, may not be the forerunner of some of the obscure lymphatic and blood diseases of later life. Many anemias are far from solution. Perhaps sarcoma, known to affect the small gut most often, may find its cause and its origin in lesions of this type which have not been recognized with any frequency until very recent years. The tissue in our case was very like lymphoid tissue. Or was it not?

Since 1932 (Tumen), 200 cases have been recorded and the opportunity for study, clinical, pathologic, and etiologic, has been

great. The symptoms of the different pictures have been well described in the literature. The chief symptoms are lassitude, anemia, poor appetite, failure to gain weight, abdominal pains of cramping type, borborygmus and constipation even to obstruction in the chronic cases. Marked distention of the intestinal loops, spasmodic in type, is characteristic. Later a palpable mass over the affected loop is strong evidence of this disease. These symptoms do not differ much from those of malignant growths. In either case the indications for operative treatment are the same.

In acute cases, fever, sharp pains, diarrhea, loss of flesh and strength, with fistula formation or matting together of intestinal coils, again point to "regional ileitis" and also to malignant disease. The differentiation is not easy.

Too much cannot be said of the value of the roentgenographic study in the diagnosis of gastrointestinal lesions. Frequently, however, they show but little in these cases unless the lumen of the bowel is completely blocked. In some of the chronic cases the "string sign," mentioned by Kantor, shows the narrowed loop. Kantor advised standard opaque meals, and repeated, even hourly, examinations in the prone position from three to nine hours after the meal.

If a barium enema spills over the ileocecal valve, the deformity in the terminal loop may show. Hyperplastic tuberculosis, lymphadenoma or sarcoma of the terminal ileum will give a similar picture. Other films will show fixation of the loops and the characteristic "string sign." An abnormal picture is important even when the exact lesion cannot be definitely determined.

In ulcerative cases one would expect to find rests in addition to the findings just mentioned. Extensive fistulous changes should show considerable deformity, but often nothing is seen. Patience and repeated observation will prove worth while. The patient should not be put to needless expense, but the roentgenologist is the best judge of what measures are necessary to obtain results. The greater his experience the better the result obtained. When a definite intra-abdominal lesion of some sort is strongly suggested by the findings, the open abdomen in competent hands offers the final solution of the problem.

Formerly, such cases seen at operation would immediately bring up the question mentioned by Pemberton and Brown, "Are you sure it is not tuberculosis?" Within recent years we have seen less of abdominal tuberculosis—a compliment to curative and preventive medicine.

TREATMENT

The treatment of these lesions must for the most part be empiric until the cause is known. For the deformities and the stenosis so often present surgical operation is advised. Methods and procedures are described in the literature.

CONCLUSIONS

We wish to offer some perhaps abrupt statements which may seem too fanciful, but which may at least lead surgical thought toward the solution of some of the hitherto insoluble problems in the field of disease. All observers should certainly stop, look and listen where so little is known and where there is so much to be learned.

What is unknown of regional ileitis?

1. Its causation is no further understood than at the time of the first report.
2. Is it bacillary?
3. Is it due to a parasite as some form of ameba?
4. Is it due to some worm?
5. Is it due to a fungus?
6. Is it due to chemical or mechanical irritation?
7. Is it due to a spirochete?
8. Is it due to micro-organism, one of the bacteria, or to an ultramicroscopic virus?
9. Why so little progress until the present?

Undoubtedly the known facts are:

1. A peculiar disease of the small bowel and colon.
2. It affects most often young males.
3. It may be acute or chronic.
4. It involves most frequently the terminal ileum.
5. It causes narrowing of the lumen and stenosis.
6. It may produce ulceration, the formation of adhesions, fistulae, and abscess formation.
7. It produces lassitude, anemia, loss of flesh and strength.
8. The pathologic picture is similar to but not identical with that in inflammatory conditions.
9. There is present the formation of new tissue and in this it resembles interstitial tuberculosis, lues, and malignant disease, and like the latter may result in ulceration.
10. Its granuloma grossly resembles that seen in tuberculosis, blastomycetes, and other mycotic lesions, lymphadenoma, Hodgkin's disease, sarcoma and carcinoma. The microscopic pictures differ in these conditions so that a competent pathologist can as a rule differentiate the exact lesion by a study of the history, the gross and the microscopic structure of the tissue.

A number of diseases formerly grouped as cancers, by the studies in pathology and by investigations as to causation, have been removed from such grouping and their true nature, their causation, their symptoms, their pathology and their curative treatment placed on a firm scientific basis. Is it not possible that the intensive study of ileitis, the causes and pathology of which are not known, may show the way more clearly to the discovery of the causes of cancer, sarcoma, Hodgkin's disease, lymphosarcoma, leucemia and other forms of anemia? All these conditions are obscure in their causation and their early development.

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SURGICAL REMOVAL OF LARGE RETROPERITONEAL SACROLUMBAR GANGLIONEUROMA

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ALTHOUGH Loretz[1] in 1870 was the first to describe a well authenticated case of ganglioneuroma, it was not until 1898 that the first case of a ganglioneuroma located in the pelvis appeared in the literature. In that year Busse[2] reported a case of a retroperitoneal tumor in the pelvis weighing 700 Gm., found in a boy 4 years of age. The following year Cripps and Williamson[3] reported one in a young woman 21 years of age in which an operation was performed successfully. Since then ganglioneuromas located in the pelvis have been reported by Chiari,[4] Beneke,[5] Braun,[6] Schorr,[7] Kehrer,[8] and others.

In 1931, McFarland[9] reviewed the literature and collected only ninety-three cases of ganglioneuromas. These he grouped as to their location found on the body.

It is probable that these tumors are much more common than the review of the literature would indicate. They are seldom diagnosed before operation, and at times after operation they are diagnosed fibromas or fibrosarcomas, which they so closely resemble.

Although the term neuroma was first used by Odier[10] in 1803, it was loosely applied to any tumor related to a nerve. It was not until 1863 that Virchow[11] placed the pathology of neuromas on a histologic rather than on a clinical basis. He classified neuromas into true and false neuromas (pseudoneuroma). The true neuroma is derived from specific nerve tissue, being the result of hyperplasia of ganglia. It consists principally of medullary and nonmedullary nerve fibers and of ganglion cells. False neuromas arise from the connective tissue of nerves or the sheath of Schwann and are fibromas, sarcomas, neurinomas, or some other tumors.

It was, however, Pick and Bielschowsky[12] in 1911, who first revealed the close relationship between ganglioneuromas and the sympathetic nerve elements, and classified true neuromas on an embryonic basis. They named them embryonic sympathetic gangliomata. They emphasized the fact that neuromas consisted of nerve cells, originating either from the sympathetic nervous system or the cerebrospinal nerves and ganglia. When the ganglions were in abundance, the tumor was called a ganglioneuroma, and when considerable mixture with glia was present, a ganglioglianeuroma.

These tumors are now considered to develop at the site of cell nests that had become misplaced or miscarried during migration of the ganglionic crests during embryonic life, and, therefore, are congenital in origin.

By the degree of differentiation of these misplaced cells mature or benign and immature or malignant forms of neuroma may occur.

The gross picture of a ganglioneuroma is that of a moderately firm, elastic, nodular tumor which varies from the size of a pea to that of a man's head. It possesses a distinct but ragged capsule which retracts when incised, causing an eversion of the incised edge. Sectioning usually reveals a glistening, translucent, pale yellowish pink tissue in which septa of connective tissue divide the cut surface into relatively large lobules. These fine trabeculae course through the tumor much as they do in a fibromyoma.

The microscopic picture is quite characteristic. Both nerve and connective tissue are present. One can see bundles of nerve fibers in longitudinal and transverse sec-

tions lodged within by a connective tissue stroma. Numerous ganglion cells, singly or in groups, occasionally with naked axis cylinders, are prominent. They may be large, globular, unipolar or multipolar. The cytoplasm is slightly granular and usually contains tigroid substance. Extending from the cell body one or more processes may be found. The deeply staining nuclei are usually round and contain fine small granules, and a fine distinct nuclear membrane. Often a nucleolus is present. Occasionally the cells are multinucleated. The stroma in some areas is dense, in others, loose and fine. It consists of numerous neurofibrils which may be brought out by special staining methods. Areas of degeneration and even calcification may be present in the tumor.

Ganglioneuromas have been located in all parts of the body, but they are most prominent in the retroperitoneal spaces of the thorax and abdomen. They have been found in the brain (Schmincke,[13] Courville[14]), in the Gasserian ganglion (Risel[15]), in the appendix (Oberndorfer,[16] Lichtenstein and Ragins[17]), in the intestines (Poate and Inglis[18]), and even in the knee (Hagenback[19]).

The tumor, as a rule, is solitary. However, Kredel and Beneke's[20] patient had 160 and Knauss'[21] patient sixty tumors. It is slightly more frequent in women than men, more on the left side of the body than the right, and more prominent in the first twenty years of life. The oldest patient in which the case was reported was in a man 76 years old (Weichselbaum[22]).

The tumors tend to be of fairly large size, especially in the younger individuals. Yet, the more benign the tumor, the more advanced the age incidence. That these tumors may become malignant is well demonstrated in the cases of Kredel and Beneke,[20] Martius,[23] and Jacobsthal.[24]

The symptoms are variable and may be entirely absent if the tumor develops in locations where no symptoms may be produced, and under such circumstances it is often an accidental finding at autopsy when the patient had died of some other disease.[25] Occasionally a tumor may give rise to symptoms for a short or long period of time, by displacement or pressure on the neighboring organs and nerves. Bigler and Hoyne's[25] first case is a good example of this. The tumor was located in the mediastinum, causing displacement and compression of the trachea with the clinical picture of a laryngeal or tracheal obstruction. In Williamson's case, the tumor which was located on the sacrum caused dysmenorrhea and at the same time displaced and anteflexed the uterus.

The prognosis is usually good. The majority of the tumors are benign, and harmful only because of pressure upon the surrounding vital structures. These tumors are slow growing and have been known to have been present for years and have little or no tendency to become malignant. However, the prognosis is best in all operable cases even though there is microscopic evidence of early formative cells (undifferentiated or immature cells). Up to the year 1931, thirty-nine cases had been operated on with only five deaths.

As to treatment, surgical removal seems to be the only cure. Roentgen ray therapy has been tried without noticeable results (Sommerfelt[26]).

CASE REPORT

R. K., a married woman, aged 25 years, a registered nurse, had been perfectly well up to January, 1936, when she began to complain of progressive loss in weight, nervousness, and constipation. She sought medical attention and was advised by her doctor to have her tonsils removed. In April, 1936 she had a tonsillectomy performed. This was followed by a further loss in weight down to 94 pounds. A bilateral neuritis of the upper extremities was present to January, 1937. A roentgenogram of the chest taken during this period was found to be normal. The patient then apparently began to improve in strength and gained weight until October, 1937. At this time she noticed a constant lumbosacral backache that progressively grew worse, that was not relieved by rest in bed and applications of heat, that was not

associated with menstrual periods, and that made the patient resort, at times, to sedatives in order to obtain some sleep. She described the constant pain as dull and dragging, nonradiating, with occasional exacerbations. Although the patient had been constipated for years, she had not resorted to enemas or cathartics until the last few months in order to have a bowel movement. She also noticed during these last few months a heavy sensation in the rectum on attempting to have a bowel movement.

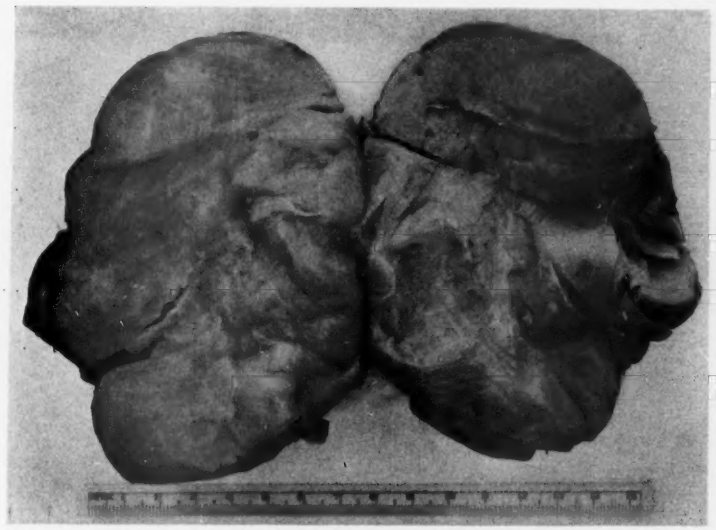

Fig. 1. Gross appearance of the tumor.

The first week in January, 1938 she noticed that she was having tarry stools unassociated with any gastrointestinal complaints except excessive eructation and progressive constipation.

Her past history revealed that she had had the usual diseases of childhood—whooping cough, measles, scarlet fever, chickenpox, and mumps. She also had had a severe case of anterior poliomyelitis at the age of 3 which kept her in bed for six weeks. Tenectomy operations were performed on her right leg when she was 7, and on her left leg when she was 10. She started to menstruate when she was 17 years old. Her periods had been regular every twenty-eight days, lasting three or four days, with moderate bleeding, always associated with severe dysmenorrhea and premenstrual pain in the breasts. The premenstrual pain was distinct and separate from the pain noticed in the sacrolumbar region. Although married three years, the patient had made no attempt to become pregnant. Her family history was essentially negative. There was no history of cancer or tuberculosis in the family.

There was a slight lumbar kyphosis of the spine, but no shortening of either leg. There was slight tenderness in the epigastric region on deep palpation. A firm hard rounded mass was palpable just above the pubic symphysis, apparently extending into the pelvis. The liver, kidneys, and spleen were not palpable. Vaginal examination revealed a long conical cervix that was displaced forward and upward, pointing almost at right angles to the right side. A firm nodular mass, the size of a four months pregnancy, appeared to fill the pelvis, more prominent on the right than on the left. Bimanually, the uterus was found to be markedly anteflexed immediately behind and to the left of the symphysis pubis. It appeared infantile in size and could be easily moved away from the mass. Rectal examination revealed the mass to be adherent to the sacrum and lumbar regions. The coccyx was free and not attached to this mass. The bowel appeared to be displaced to the left but moved freely over it. Bimanually, it was possible to move the tumor slightly out of the pelvis for a distance of ½ to ¾ of an inch by exerting pressure through the posterior wall of the vagina.

Roentgen ray examinations of the stomach, duodenum, small bowel and colon, including a barium enema proved essentially normal. Roentgenograms of the spine and pelvis revealed a lumbar sacral kyphosis of the spine and an indefinite shadow in the pelvis corresponding to the palpable tumor mass. An Ewald test revealed a total acidity of 64, and a free HCl of 38. Repeated stool examinations showed no macroscopic but positive chemical

(benzidine) evidence of blood. Examination of the blood showed 4,400,000 red cells, 9,000 white cells, and 80 per cent hemoglobin. There

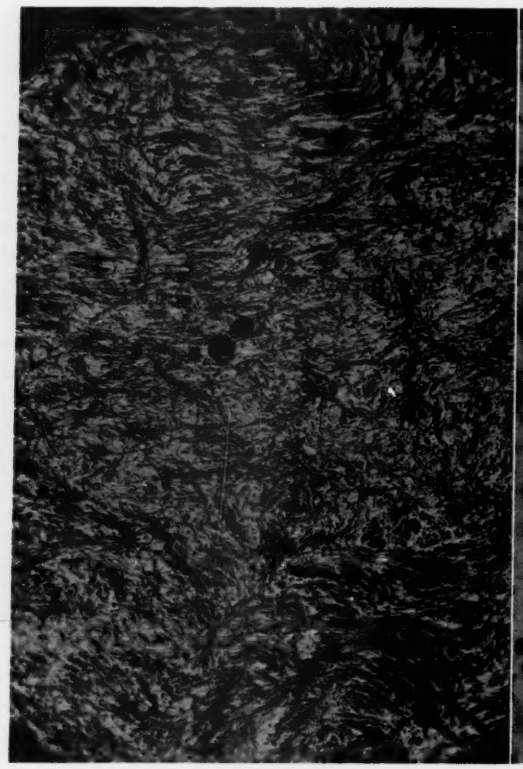

FIG. 2. Section of tumor revealing numerous ganglion cells scattered throughout. The numerous round nuclei are oligodendrocytes, the fibers are mostly nerve axones; the dark round cell bodies are ganglion cells. (Bielschowsky stain; × 125.)

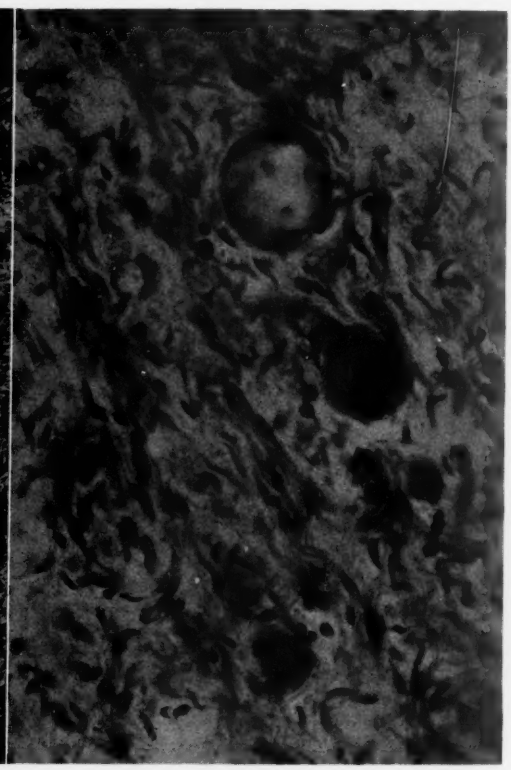

FIG. 3. Section of tumor revealing several ganglion cells with distinct nuclear membranes, surrounded by a variety of cells. The round nuclei are oligodendrocytes, the oblong are Schwann cells. (Crystal violet stain; × 500.)

was a lymphocytosis of 67 per cent. The urine was normal and the Wassermann test negative.

The mass was considered as probably an ovarian tumor or a retroperitoneal or broad ligament fibroma.

Through a lower midline incision with the patient in the Trendelenburg position, an exploratory operation was performed. The uterus was small, anteflexed and displaced to the left. The tubes, ovaries and broad ligament were healthy. The tumor was found behind the uterus, retroperitoneal and in front of the sacrum. The posterior parietal peritoneum was incised. An attempt to shell out the tumor with the fingers was successful. Separation from the peritoneum was easy, but some difficulty was noted in separating with the fingers the firm attachments between the mass and the anterior aspect of the sacrum.

Immediately after the tumor was removed, with some difficulty, through the abdominal incision, the patient became very pale, the pulse became very faint and over 172 per minute, and the blood pressure dropped to a systolic of 60 mm. The stomach was seen to dilate very rapidly, with the greater curvature appearing at the wound. To combat the severe shock, the anesthetic was stopped and the patient was given immediately CO_2 and O_2 inhalations, and 1 c.c. of adrenalin and 1 c.c. of coramine solution. Intravenously glucose, five per cent solution, was given freely. Because the patient responded poorly to the stimulants, the cavity was immediately packed with sterile gauze and the wound rapidly closed in layers.

The patient remained in severe shock for several hours with respirations at times six to eight per minute. She had a stormy course for several days with abdominal distention and lower sacral pain, but was up and around and completely free of pain in two weeks when she went home.

The tumor (Fig. 1) measured 7.5 × 12 × 14 cm. and weighed 600 Gm. The specimen was ovoid in shape, slightly lobulated, and

covered by a ragged, thin but firm capsule. The knife cut it with a grating sound. The tissue appeared firm and elastic and did not contain any visible blood vessels. The cut surface revealed a glistening pale yellowish pink, tissue.

On microscopic examination the tissue proved to be mainly neurogenic. A specimen was submitted to Dr. G. B. Hassin, Professor of Neurology at the University of Illinois. Through his cooperation we are able to submit his report on the microscopic picture:

"The tumor mass consists of ganglion cells (Fig. 2) and numerous nerve fibers devoid of myelin but supplied with well developed Schwann cells. (Fig. 3.) The Schwann cells are predominating elements in the field of vision, appearing in the form of oblong, darkly stained nuclei (especially well seen in the silver stained specimens). Other cell bodies are represented by round nuclei, the size of lymphocytes, which they much resemble, and are so called glia nuclei or oligodendrocytes. It is also possible to make out oval pale nuclei which belong to the endoneurial connective tissue membranes of the nerve fibers. Some areas exhibit quite numerous ganglion cells in the form of round bodies, their nuclei situated at the periphery and their cytoplasm homogenous or slightly granular often containing pigment. In their appearance the ganglion cells are similar to those seen in the sympathetic nervous system. The axones of the nerve fibers (Figs. 2 and 4) are often spindle shaped, varicose, sometimes quite thick and deeply stained, but in the majority of instances are as thin fibers lines by Schwann cells which in their turn are enveloped by an endoneural membrane. The fibers so numerous over the visual field are connective tissue, others—the majority—are glial."

The diagnosis was ganglioneuroma.

The patient was given 250 units of antuitrin-s several months later, the substance being given twice a week for three months. The uterus became normal in size and the patient subsequently became pregnant. A 6 pound female infant was delivered December 2, 1939 by cesarean section. Both mother and child are in excellent health.

SUMMARY

A case of retroperitoneal sacrolumbar ganglioneuroma in a young woman is reported.

Ganglioneuromas are now considered tumors of congenital origin, arising from the differentiation of misplaced multi-

Fig. 4. Note large ganglion with distinct peripheral nucleus, with granular cytoplasm and deeply staining axone. (Bielschowsky stain; × 368.)

potential embryonic neurocytes. These tumors may be present in any region of the body, but the majority have been located in the retroperitoneal spaces of the thorax and abdomen.

The only cure is surgical removal.

Profound serious surgical shock should be anticipated with the removal of large ganglineuromas.

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CALCIFYING TENDINITIS TRAUMATICA

DIAGNOSIS AND TREATMENT OF POST-TRAUMATIC CHANGES IN AND ABOUT JOINTS

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IN a previous publication the author[1] reported a case of tendinitis ossificans traumatica. A review of the literature was made at that time and the theories of heterotopic bone formation were discussed. Since that publication many excellent case reports and clinical observations of similar nature have been made. The purpose of this paper is to report three cases of calcification resulting from injury to tendon and ligamentous tissue involving the elbow, knee, and shoulder. It is very likely that ossification often results from or is preceded by calcification. In this manner heterotopic bone formation may occur.

A mass of evidence is accumulating which indicates that para-articular calcification is a frequent result, both early and late, of trauma in and about the joints. The pathologist recognizes this as one of the results of tissue disintegration and repair. By understanding the pathologic changes the orthopedist is better able to arrive at the proper method of treatment. Callen,[2] in an excellent article on Pellegrini-Stieda's disease, draws the conclusion that this particular condition is not a disease entity but represents a local manifestation in the knee of post-traumatic changes common to other joints. Three case reports are herewith presented. In the writer's opinion, each presents evidence that Callen's conclusion is justified.

CASE REPORTS

CASE 1. B. H., female, age 29, was admitted to the Miami Valley Hospital on December 20, 1935, with a chief complaint of swelling and tenderness about the left elbow. Moderately severe trauma to this joint had occurred three months before admission, but there were no symptoms in the interim. Four days previous to admission swelling with pain again appeared, this time without any associated trauma, and became progressively worse. Aspiration had proved unsuccessful.

Examination of the elbow revealed a lemon-sized, non-fluctuant swelling, with a dully inflammatory reaction over the external condyle. This swelling was exquisitely tender. Motion was painless between 45 and 130 degrees. Beyond these limits motion was restricted by pain. Pronation and supination were free. There was no physical or mensurable atrophy. The temperature was 98.6°F. The remainder of the general physical examination was not significant.

Urinalysis showed nothing of significance. The red blood cell count was 4,000,000; the white blood cell count was 7,700; hemoglobin was 76 per cent. Differential showed polymorphonuclear filaments 39, nonfilaments 35, lymphocytes 20 per cent, monocytes 4 per cent, eosinophiles 2 per cent. Sedimentation time was one hour, eleven minutes. The Roentgen examination showed an area of increased density about the external condyle. No significance of this shadow was recorded.

On December 21, due to the persistence and severity of symptoms, the region was explored. A thick, caseous, chalky abscess was encountered in the radial collateral portion of the joint capsule. The abscess was evacuated and the wound closed without drainage. Short wave diathermy was instituted after the joint was immobilized in plaster splints. The convalescence was uneventful and the patient has remained well. Smears and cultures made at the time of the operation revealed no micro-organisms.

The pathologic report of adjacent tissue showed that it was composed of broad bands of hyalinized fibrous tissue containing localized areas of lymphocytic infiltration and organizing inflammatory fibrosis. There was considerable reticulo-endothelial hyperplasia of many of the new formed blood vessels in the area of active

chronic inflammation. No evidence of tuberculosis or malignancy was reported.

Case II. R. B., male, 16, was seen November 11, 1937 because of a painful, swollen left knee. Seven days previously he had been "tackled in football." The blow was received on the unprotected knee and the patient fell with the body weight landing on the lateral aspect of the knee. There was immediate disability with pain. Swelling was marked within the hour, and the knee had remained swollen. There was generalized tenderness and constant pain, particularly in the anterior and posterior thigh muscles.

Examination of the knee revealed swelling, marked effusion and generalized tenderness. Motion was limited in flexion to 110 degrees and in extension to 165 degrees. There was slight atrophy (1.5 cm.) of the thigh. Roentgen films showed area of increased density without bony trabeculations lateral to the external condyle. Aspiration yielded 150 c.c. of bloody exudate. A diagnosis of calcification in the capsule with hemarthrosis was made.

Fig. 1. Case I. An area of increased density in the joint capsule about the external condyle, without bony trabeculations, the result of trauma.

Fig. 2. Shadow removed and proved to be a calcified deposit.

A Shantz compression dressing was applied. After five days the dressing was removed, and the extremity was immobilized in a bivalved plaster cast. Diathermy was then instituted. Roentgen examination January 4, 1938 showed the complete absorption of the shadow. In eight weeks there was complete function with no complaints.

Case III. H. S., male, age 51, complained of discomfort followed by pain in abduction of the right shoulder of three days' duration. Examination revealed deep tenderness over the great tuberosity of the right humerus. Abduction was limited by pain. Internal and external rotation were free. The patient was a dentist, and short wave diathermy was given for symptomatic relief to enable him to continue his professional duties for that day. Following one treatment, much of the distress was relieved and he desired to continue on this form of therapy. Treatments were given three times a week. In two weeks the patient was without symptoms. The area of calcification in the supraspinatus tendon was nearly absorbed.

As in Case III, these deposits have been shown by Codman[3] to be in the tendinous

Fig. 3. Case II. Area of density n joint capsule about external condyle of femur. Result of trauma.

Fig. 4. Complete absorption as result of conservative treatment.

Fig. 5. Case III. Calcified deposit in supraspinatus tendon.

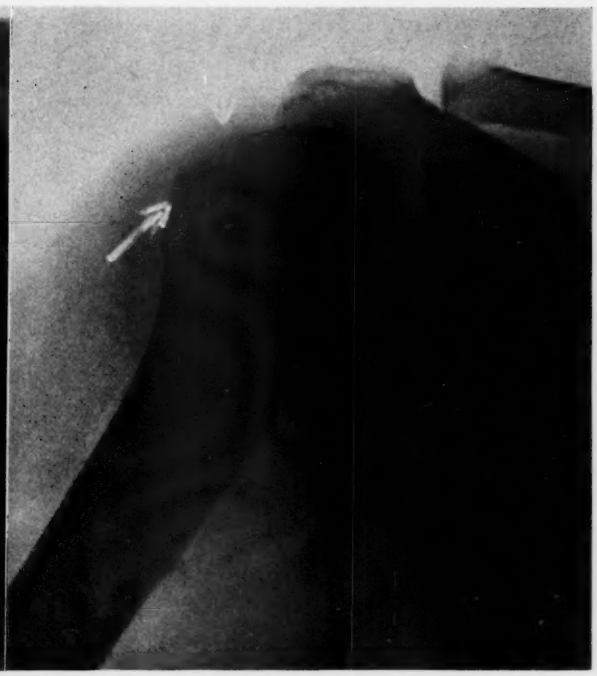

Fig. 6. Same shadow after conservative treatment by short wave diathermy. Marked absorption had taken place.

insertion of the supraspinatus muscle or in the shoulder capsule, since these two structures are so intimately blended in the region of the trochanter. Mumford[4] has clearly shown some of the favorable results to be expected with diathermy. Here it was chronic occupational trauma rather than sudden injury that caused the joint manifestations.

COMMENTS

The exact process by which traumatized tendon fibers calcify and often later ossify has not been clearly demonstrated. Klotz[5] pointed out that calcium soaps may be an intermediate step between the fatty acids, a disintegration product, and the final calcium deposits. The chemical analyses of these deposits have not varied greatly in the reports of many writers. A physicochemical process may occur, according to Karsner,[6] in which the necrotic material attracts calcium and the precipitation depends upon carbon dioxide concentration. The ready response to hyperemia with added nutrition to these devitalized tissues tends to show that the latter may be correct. Hyperemia induced by short wave diathermy has been shown in these case reports to result in an early absorption of the deposits. The pathologic findings in one case revealed active chronic inflammation. There is nothing to justify the assumption that calcification would be the result of these cellular changes. With the rapid response to diathermy, fewer pathologic and chemical studies will be available.

CONCLUSIONS

1. Three cases of calcifying tendinitis are presented.

2. It is probable that the process in the three joints of different location are identical.

3. Recognition of the chemical and pathologic changes provides a good explanation for the favorable responses to conservative treatment.

4. In the type of heterotopic bone formation resulting from osteoblastic proliferation, surgical removal is usually necessary.

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CHONDROSARCOMA OF THE STERNUM*

REPORT OF A CASE

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MALIGNANT cartilaginous tumors of the sternum are exceedingly rare. In 1932, Heuer[1] reviewed the literature on neoplasms of the sternum and reported a case of chondromyxoma of the sternum, which, although histologically benign, gave rise to local and mediastinal metastases one year later. Heuer's case was the thirty-eighth reported malignancy of the sternum. Of these, only four were primary cartilaginous growths, the rest being either sarcomata or metastatic malignancies. Thirty-four radical operations were carried out in these thirty-eight cases and the immediate operative mortality was 23.5 per cent. Of the remaining twenty-three cases the end results were given in only thirteen. Nine of these showed recurrences within two years and six died in that time.

FIG. 1. *X*-ray taken March 1, 1938, showing soft tissue mass in superior mediastinum.

* From the George P. Muller surgical service, Jefferson Medical College Hospital, Philadelphia.

Roberg[2] in 1935 reported a case of "chondroma" in a woman of 39. Radical resection of the upper sternum and ribs was carried out. The diagnosis histologically was chondroma with partial transition to sarcoma. Local recurrence and pulmonary metastases occurred within one year. This author stressed the uncertainty of character of primary cartilaginous tumors and the difficulty in determining the prognosis.

Because of the rarity of the condition we are reporting the following case of chondrosarcoma of the sternum.

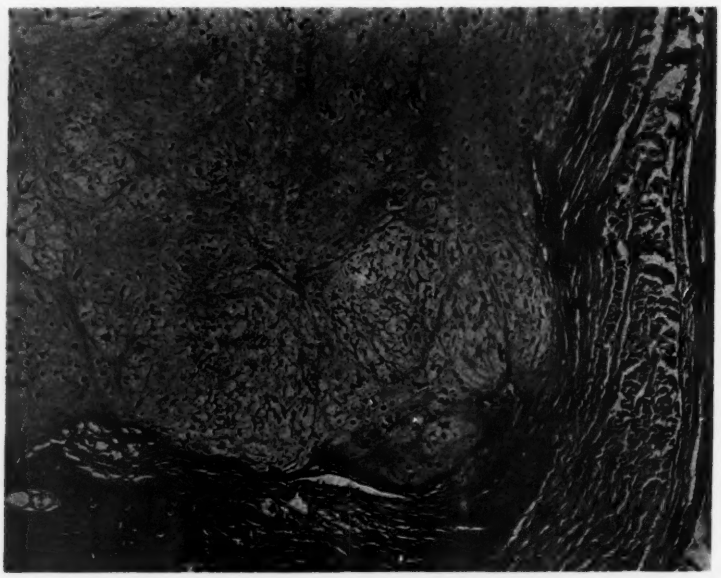

FIG. 2. Photomicrograph (× 100) of section from margin of tumor. The growth is cellular and is made up of undifferentiated cartilage cells.

CASE REPORT

M. B., female, aged 49, entered Jefferson Hospital on March 14, 1938 complaining of a mass over the upper end of the sternum. This had been present for four years, following a fall, and had been growing slowly since it first appeared. In 1935 a course of *x*-ray therapy was given, following which the mass remained stationary in size. In the previous year, however, the mass had again been growing slowly. There was no history of difficulty in breathing or swallowing. No cough or expectoration was present. Very occasional pains were noted in the suprasternal notch.

Physical examination was negative except for the finding of a firm, fixed mass, about the size of a lemon, over the inner ends of both clavicles and the upper end of the sternum. *X*-ray examination on March 1, 1938 showed an indefinite soft tissue mass in the anterior portion of the superior mediastinum. The lung fields were clear.

On March 16, operation was performed under endotracheal cyclopropane-ether-oxygen anesthesia. A curved incision, with the concavity upward, was made across the upper sternum and the medial ends of both clavicles. The clavicular portions of the sternomastoid and pectoralis major muscles were separated from the manubrium and clavicles. A soft cystic swelling was encountered and a biopsy for frozen section taken. This was reported as suggestive of malignancy. Blunt dissection was then carried out behind the manubrium, separating the mass from the upper mediastinal structures. Openings were made in the second interspace on both sides and the pleurae and mediastinal structures separated from the posterior aspect of the sternum. The internal mammary arteries were ligated. The upper portion of the sternum, containing the mass, and the inner ends of both clavicles were then removed en bloc with a Gigli saw. The left pleural cavity was accidentally opened during the procedure. The opening was immediately

sutured. The incisions were closed, leaving one rubber drain under the skin. The pneumothorax was immediately aspirated. The patient left the operating room in good condition.

Pathological Description. The tumor was a firm, nodular mass which included the upper end of the sternum and the attached ends of both clavicles. The greater portion of the upper end of the sternum was replaced by a firm, nodular growth which had the appearance and consistency of cartilage. Some areas were very soft and hemorrhagic. The lower portion of the sternum appeared normal. No evidence of involvement of the clavicles could be demonstrated.

Microscopic sections showed largely cellular cartilage and fibrous tissue which formed distinct nodules. In some areas the cartilage cells were large, hyaline and adult in type but in other areas the bizarre type of nuclei suggested myxomatous tissue. The connective tissue stroma was very vascular in areas. Some nodules of cartilage could be observed in the attached muscle tissue.

While the greater portion of the growth was composed of cartilage, because of the cellular nature and the involvement of the surrounding tissues the lesion was considered malignant.

The diagnosis was chondrosarcoma of the sternum.

Postoperative Course. On March 18, 1938, *x*-ray of the chest showed evidence of a hydropneumothorax on the left side with displacement of the heart to the right. On March 19, a brace was applied to keep both shoulders from falling inward, because of lack of clavicular support. A moderate degree of dyspnea and cyanosis developed and signs of a large collection of fluid in the left pleural cavity appeared. On March 28, stereoscopic *x*-rays of the chest revealed a density throughout the left chest with displacement of the heart to the right. On March 30, the left pleural cavity was tapped and 550 c.c. of serosanguinous fluid removed.

The hydrothorax gradually cleared up, although the convalescence was further complicated by bilateral femoral phlebitis. The patient was discharged with the wound well healed on May 3, 1938.

The patient was last seen at the beginning of February, 1940, twenty-three months after operation. The scar was well healed and there was no evidence of local recurrence. The brace had been discarded and there was no deformity and no impairment of motion of the arms.

SUMMARY

1. A case of chondrosarcoma of the sternum is reported.

2. The operative technique is described.

3. The fact that the inner ends of both clavicles were removed without any impairment of function is noted.

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CARCINOMA ORIGINATING IN AN OBSTRUCTING GASTRIC ULCER*

CASE REPORT

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BECAUSE recent articles[3,4] have stated that gastric ulcers seldom if ever become malignant, we wish to submit the following brief case report. We agree with MacCarty's many contributions[1,5,6,7] that a gastric ulcer should be viewed as a possible premalignant lesion and should be treated accordingly. All uncomplicated gastric ulcers must first be given an adequate trial under medical treatment in a hospital bed, for a period varying from six to eight weeks. If, after the expiration of that interval, epigastric abdominal distress still persists, or melena and hematemesis continue, or the gastric roentgenogram shows no evidence of healing, prompt surgical measures are indicated. Either an intractable gastric ulcer or an ulcerating gastric carcinoma is present, and medical measures will not suffice.

FIG. 1. Twenty-four hour roentgenogram showing almost complete gastric retention by an obstructing ulcerating pyloric lesion.

FIG. 2. Gross specimen, showing a large obstructing gastric ulcer near the pylorus. The ruler is placed at the pyloric end of the stomach. A, obstructed pylorus. B, site of the carcinomatous change originating from the margin of the ulcer.

Five-year follow-up studies in unselected cases of gastric carcinoma, show that only 1 to 5 per cent of the original group remained alive. Thus, the only hope of saving more of these individuals must lie in the direction of earlier recognition and prompt treatment of the premalignant and early malignant lesions. Particularly valuable has been the contribution of Alvarez and MacCarty[1] basing the probability of malignancy on the diameter of the gastric lesion.

* From the Departments of Surgery and Medicine and the Pathology Laboratory, Presbyterian Olmsted Memorial Hospital, Hollywood. Presented before the staff meeting of the hospital, September 27, 1938.

CASE REPORT

Mrs. R. E., white housewife, aged 68 years, entered the Presbyterian Olmsted Memorial Hospital on September 10, 1938.

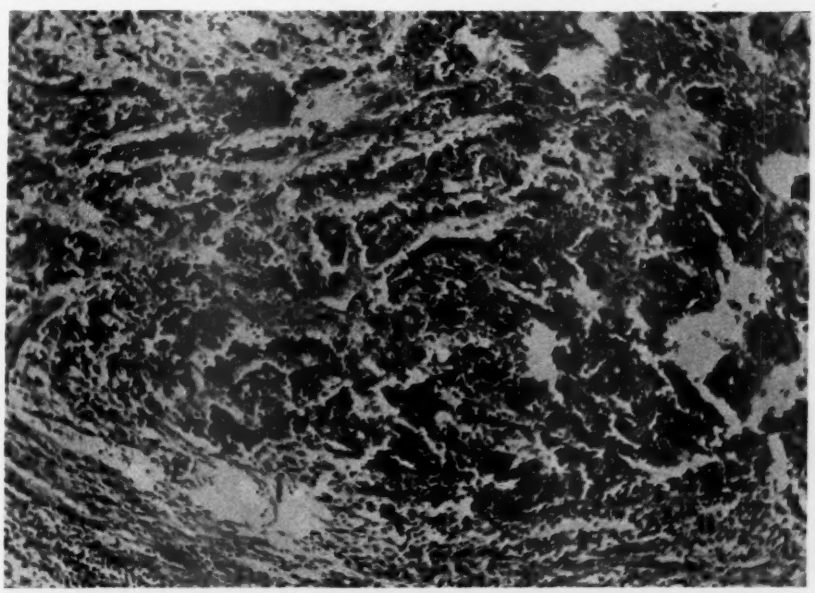

Fig. 3. H. and E. stain. Typical low power area of the carcinoma. Note lack of glandular formation. The protoplasm of the malignant cells stains a deep pink, indicating that possibly this neoplasm arose from the parietal cells of the stomach. (× 100.)

She complained of inability to eat, weakness, anorexia, epigastric fullness and distress, which had begun about six months before.

She had taken some proprietary drugs for the relief of the vague abdominal distress, but it had gradually increased and was partially relieved by food. One month before admission anorexia and increasingly marked regurgitation of solid and then liquid foods, together with severe epigastric distress had occurred.

The patient weighed 115 pounds, having lost 9 pounds in six weeks. Blood pressure was 148/70. A small palpable mass in the right epigastrium was questionable.

Urine analysis was negative. The red cells numbered 4,000,000 per cu. mm., the white cells 6,350, with polymorphonuclears 54 per cent, lymphocytes 40 per cent, and monocytes 6 per cent. Hemoglobin was 66 per cent (Sahli). Coagulation time was 3½ minutes (Boggs).

Roentgenologic study of the stomach (by Dr. E. N. Liljedahl) revealed a practically complete twenty-four hour gastric retention of the barium meal by an obstructing ulcerating lesion at the pylorus. (Fig. 1.)

Abdominal exploration (Sloan incision) revealed an obstructing gastric lesion at the pylorus, about 3.5 cm. in diameter, situated on the anterior wall and involving the lesser curvature. An exploratory gastrotomy with the palpating finger revealed a large obstructing gastric ulcer with one small area of marked firmness in its margin that extended toward the base of the ulcer. In view of these findings, and on account of the patient's advanced age, a posterior Polya-type gastric resection was performed, according to the Gray and Balfour technique.[2] Approximately 10 cm. of the distal portion of the stomach, including the pylorus and the proximal centimeter of the duodenum, was resected. (Fig. 2.)

The pathologic report (by Dr. V. L. Andrews) confirmed the large ulceration, which measured 3½ cm. in diameter and involved the inner part of the pyloric ring. For the most part the edges were elevated, slightly undermined. The base was quite smooth, as was the serous coat except for the manipulation of surgery. There was nothing indicative of malignancy on the serous coat.

Section through the base showed in the central part a small area of about 1 cm. a little firmer and with a pearly gray surface on the cut section. This could have been a beginning malignancy. Surrounding the ulcer and over

the inner surface of the stomach the mucosa was somewhat hypertrophied, but no other ulcerations were present.

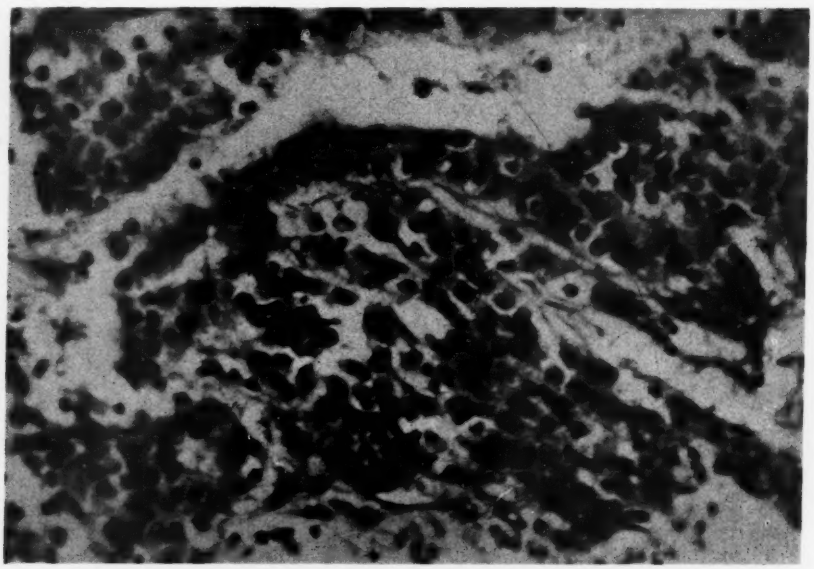

FIG. 4. H. and E. stain. High power appearance of a portion of the carcinoma. Cells show irregularity in size and shape with deep pyknosis of the nuclei. There are large collections of lymphocytes and plasma cells scattered throughout the neoplasm. (× 440.)

Sections from two parts of the tumor showed a definite carcinomatous condition, with epithelial cells infiltrating in small groups and strands. They were irregular in size and shape but stained rather deeply. The protoplasm was pink and granular. There was no attempt at gland formation. An extensive lymphocytic infiltration was present throughout. Because there was no attempt at gland formation and the protoplasm was rather pink, the possibility that the tumor arose from parietal cells was considered. (Figs. 3 and 4.)

The temperature reached its peak of 101.2°F. per rectum on the first postoperative day and then rapidly subsided. The incision healed uneventfully. No nausea or vomiting occurred. The patient's convalescence was normal. She is now ready for hospital dismissal.

CONCLUSIONS

1. A case report of a proved carcinoma originating in an obstructing gastric ulcer is recorded, and its prompt surgical resection described.

2. We believe in the fundamental concepts of Wilson and MacCarty that gastric ulcers may become carcinomatous.

3. We wish to stress, that despite recent contributions in the medical literature to the contrary, gastric ulcers are a definite premalignant lesion.

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NEW INSTRUMENTS

ATRAUMATIC RETHREADABLE SURGICAL NEEDLES

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STREAMLINING is the vogue of the day, to eliminate resistance and insure smooth performance. Why not make the principle applicable to surgical suturing? The sewing together of tissues is one of the oldest and most fundamental surgical procedures. The implements are the needle and the thread. The suture has many forms due to the needs and the whims of the operator. The needle is essentially the same now as when invented centuries ago: a sharp pointed shaft with an eye placed at the blunt end through which the suture passes at right angles to the shaft.

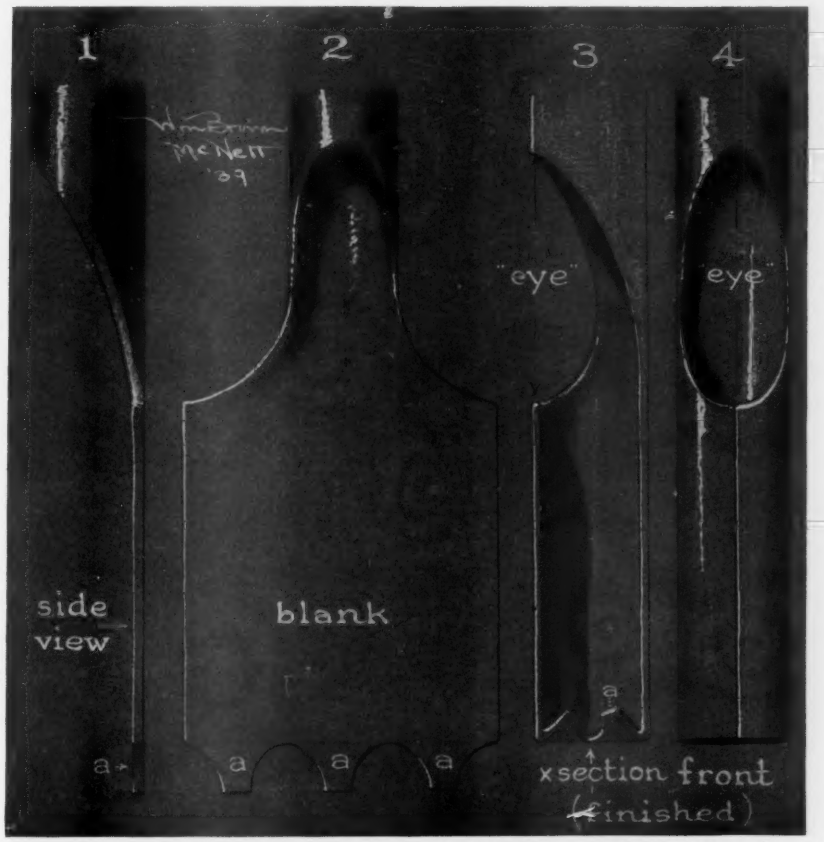

FIG. 1. Method of flattening, stamping and rolling blunt end of needle to form retaining unit for suture.

To avoid trauma and handle tissues with care is agreed to be the secret of successful surgery. A doubled piece of catgut plus the thickness of a needle can be an abrupt

sizable mass to pull forcibly through the tissues in the process of bringing these surfaces together.

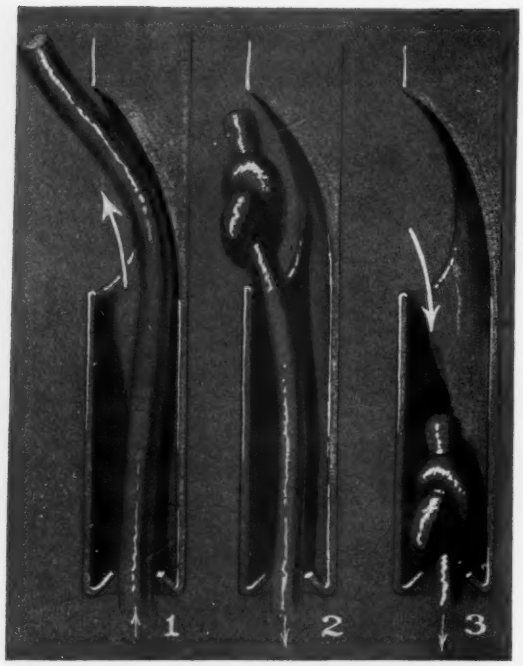

Fig. 2. Suture threaded into needle, tied into knot which is withdrawn inside needle.

We have seen frequent discussions of the relative value of various suture materials and the tissue reaction they produce. We might also concern ourselves with the tearing apart of fibrous tissue bundles, the separation of fasciculi of muscle cells, or the pulling apart of epithelial tissue masses. Small hematomas of varied significance no doubt result from this forcible separation of cellular elements. The increased pain from tissue pull in emergency suturing, where little or no anesthesia is used, should also cause consideration of the trauma caused by a doubled thread of suture material and the thickness of the needle. Often one has a needle carefully placed in the edges of a wound to approximate two delicate tissues, only to have the after-coming suture tear out as the thick doubled material is pulled through.

The atraumatic needle is already part of our armamentarium. But because most such needles are not easily rethreadable, they are not used routinely. A practical rethreadable suture would doubtless lead to more widespread use of atraumatic needles, but it should be able to be manufactured by mass production rather than by hand and should also be easily handled, quickly threaded, with no loose parts to become misplaced or dropped. The two needles described here meet these requirements.

Needle I. (Fig. 1.) The rethreadable, retaining portion or eye of the needle is as usual at the blunt end of the shaft. The process of moulding this end is accomplished by flattening out the shaft for a short distance in the manner shown in Figure 1 (1 and 2). A blank is made in which the upper margins of the flattened surface curve inward to converge with the shaft of the needle. The other extremity of the flattened area has semicircular areas punched out, leaving three prong-like projections. (Fig. 1*a*.) This stamping is then rolled on itself so that the flattened area becomes cylindrical. The cylindrical portion is continuous with and of the same size as the body of the needle. The small projecting prongs are bent on themselves so that they are directed inward toward the lumen of the cylinder. The two curved areas at the upper portion of the cylinder fit together, forming the eye of the needle in the side of the shaft. (Fig. 1-3 and 4.) The needle is threaded easily by pushing the suture through the opening at its distal end. It comes out through the eye as indicated in Figure 2-1. A knot is then tied in the suture material, the redundant end cut off, and the suture withdrawn back into the shaft of the needle as indicated in Figure 2-3.

Needle II. (Fig. 3.) This needle is simply a modification of the previous one. Perhaps it will be more easily manufactured. The formation of a blank by the flattening out of the blunt end of the shaft is the same as that described in the previous example. However, rather than make projecting elements at the distal end, small prongs are formed in the flattened material as indicated in Figure 3*b*. These prongs are

bent inwardly. A cylinder is made as described in the previous Figures 1 and 2. The needle is threaded in the same manner a wax, cellulose, or bakelite moulded swelling to be formed around the extreme end of the suture. A metal sleeve clamped

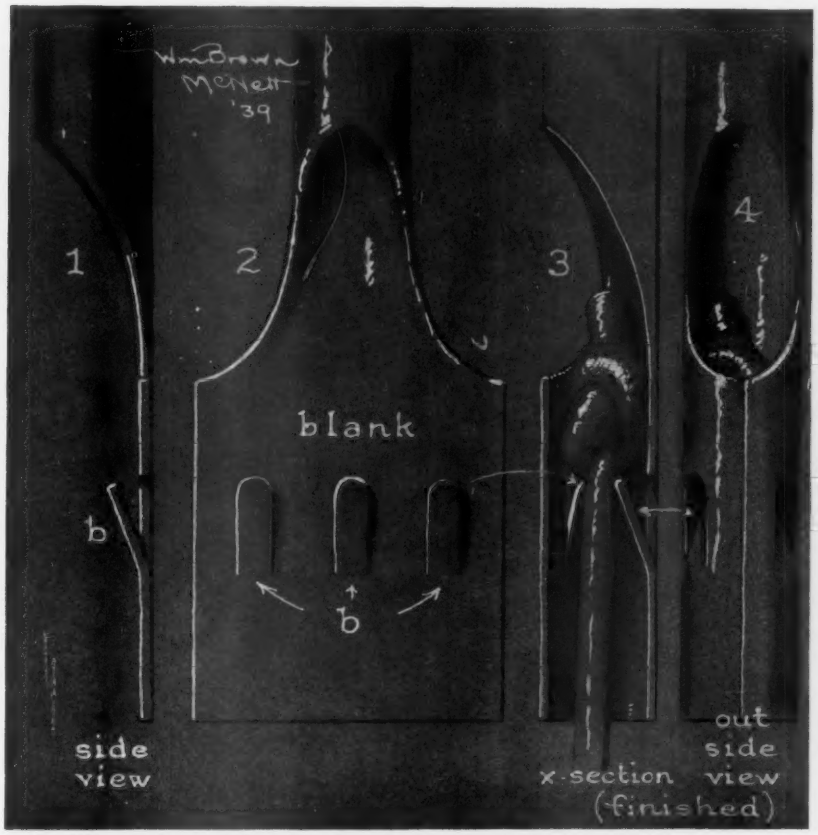

Fig. 3. Needle stamped with prongs inside of cylindrical end to hold suture in place.

with the drawing of the knot or other enlarged retaining device tightly against the flaps that have been bent inward from the sides of the cylinder. (Fig. 3-3 and 4.)

It will be noted that there is no sleeve or adjustment of locks that anchor the catgut into the needle as has been described by other writers.[11] The method of holding the catgut inside the needle is accomplished by the simple procedure of knotting the end. The knot can be displaced by a fine awl, forcing it back toward the open eye of the needle in the side of the shaft. Many other methods for enlarging the end of the suture have been suggested. The simple formation of a knot, however, is the oldest. Others consist of applying a hot cautery causing distortion of the end of a catgut suture. Logan, and later Everett, suggested around the suture and then withdrawn into the shaft of the needle was also suggested by the latter writer.

The needle does not have any groove on the side from which the catgut can slip.[2] Nor does it clamp fast to the catgut so that the suture cannot be removed for rethreading (Bigelow, Gaillard, Ovington, Lukens, and Quint). The needle is rethreadable and simple to manufacture. Both of the needles have the strength at the blunt end or eye increased rather than decreased by the method of manufacture. The cylinder makes for more resistance than a single bar shaft.

CONCLUSION

There is a definite need for a practical atraumatic rethreadable needle. The ideas

for manufacture here presented are feasible and seem to solve the major difficulties.

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Hematuria never should be treated as an ailment in itself but as a symptom of more serious trouble. The causes of hematuria are numerous, and its diagnosis and treatment do not belong to the realm of minor surgery.

A RATIONAL SCALPEL*

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THE correct use of the scalpel is one of the first technical principles learned by the surgeon. That the handle should be held so that the cutting is done by the belly of the blade is common knowledge. Yet this surgical maxim is not generally realized. This becomes obvious upon considering the types of blade usually employed.

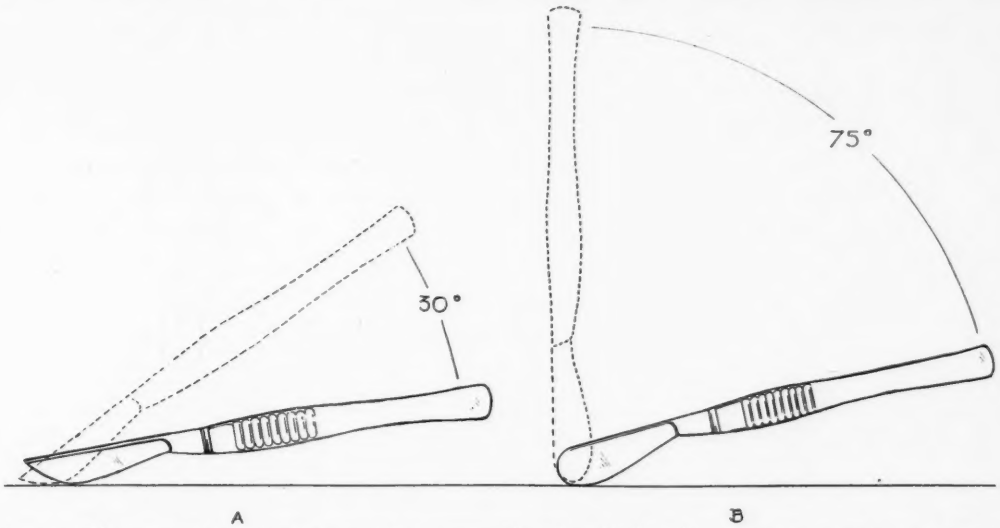

FIG. 1. Diagrammatic illustrations of A, conventional scalpel and B, type proposed. A, conventional scalpel which must be held at angles varying between approximately 15 degrees and 45 degrees in order to sever tissue with the belly of the blade. B, proposed scalpel with blade so shaped that the cutting edge forms an almost 180 degree curve at its end. Such a scalpel permits severance of tissue with belly of the blade at angles varying between approximately 15 degrees and 90 degrees with the surface to be cut.

The scalpel most commonly used by the surgeon consists of the handle with a blade characterized by one of the two general forms of cutting edges: (1) the bistoury type in which the gradually tapering straight cutting edge forms a long sharply pointed blade; and (2) the belly type in which the sharpened edge follows a graceful curve to a relatively blunt point. The former is used in making stab incisions and the latter is employed for practically all other purposes. The obvious disadvantage of this latter type of scalpel is that it must be held within restricted limits in order to sever tissue with the belly of the blade. Actually the scalpel can be held at angles varying between approximately 15 degrees and 45 degrees with the surface to be cut. If the scalpel is held at an angle greater than 45 degrees, severance of tissue is no longer performed with the belly of the blade. Thus it permits variations of about 30 degrees. (Fig. 1A.) While this is not significant in the majority of instances where the knife can be used in open areas, it becomes a real objection in those cases where severance of tissue must be done through deep wounds. In the latter instance because the limited space does not permit the scalpel to be held at the proper angle with the surface to be cut, actual severance is usually performed with the tip of the cutting blade.

With this view in mind and in an attempt to obviate this objection, a scalpel

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has been devised which is considered more rational. The blade is so shaped that the cutting edge forms an almost 180 degree curve at its end. (Fig. 1B.) Such a scalpel permits severance of tissue with the belly of the blade at angles varying between approximately 15 degrees and 90 degrees with the surface to be cut. (Fig. 1B.) The obvious advantage of this greater "bellied" blade is that it allows the surgeon to incise rationally at practically any angle it may be necessary to hold the scalpel.

FRACTURES involving sinuses are potentially the cause of infection which may proceed from the sinus itself to the adjacent soft parts. The rationale of the treatment is the reduction of the fractures and the protection of the sinuses, which is carried out by a rhinologist.

OBSTETRIC DELIVERY FORCEPS

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EAU CLAIRE, WISCONSIN

DURING the conduct of an obstetrical delivery, a physician is confronted by a dual challenge. First, he must provide the parturient patient a method of safe, speedy and effective delivery of her offspring with a minimum of pain. And, secondly, he must give the child the guarantee of a life with a body and form free from any defects of the physician's making. In normal, spontaneous deliveries these challenges are easily met. However, in abnormal cases the hazards and challenges are great and success in handling of the cases is dependent not alone upon the knowledge and judgment of the physician attending, but upon the equipment at hand and dexterity in its management.

From earliest times, the obstetrical forceps has been one of the most effective agents, when properly used, of reducing both maternal and fetal mortality. Since obstetrical forceps were first introduced by the Chamberlen family in 1584, their use has increased, until in 1931 at the White House Conference it was reported by Plass[2] that, in a series of 145,812 deliveries, the incidence of forceps deliveries was 17.9 per cent.

In addition to the four main types of female pelvis, the gynecoid, the android, the anthropoid and the platypelloid (or flat) forms, as reported by Caldwell and Moloy,[3] there is a series of intermediate forms more difficult to recognize unless their anatomic relationship to the parent type is observed and recognized.

If the android and anthropoid pelvic type is recognized, the obstetrician may find that delivery can be effected with greater ease by delivery of the head with forceps in the persistent occipitoposterior position as compensatory space exists in the posterior pelvis. It is mechanically wrong to attempt the rotation of the fetal head from a wide diameter through a narrow one. The same principle holds in the delivery of the after-coming head in a version and breech extraction. Therefore, it is logical to rotate the head to an occipitoposterior position in the inlet itself, if this is possible, in order to deliver the head in the occipitoposterior position.

With the forceps now in use, the difficulty is primarily that there is no chance for the head to rotate because of the tight grip which the operator has on the extremely rigid forceps handles. When traction is applied, the harder the operator pulls on the forceps, the harder he grips the handles. By so doing, he loses the sensation of the head within the blades which otherwise enables him to revolve the head to the larger and more favorable position within the pelvis in its descent.

The new forceps here presented resembles DeLee's modification of the Simpson forceps. It is just as easily applied and the blades are thinner; thus, it will occupy less space in the birth canal. The possibilities of free rotation with flexion and extension of the head, as well as the insertion of an elastic mechanism for the purpose of overcoming the friction of the head, is the goal sought. Consequently, this new forceps may well be considered entirely new in principle and design.

The swivel or ball joint bilaterally frees the head from any hindrance traceable to rotation, flexion or extension due to the pull of the physician. The head can gradually and fully turn automatically to conform with the diameters of the birth canal in spite of the direction of the pull exerted upon it. The rotation of the head is due to the pressure of the soft portions of the mother's body, especially posteriorly.

It is possible to prevent any hindrance to the free rotation, flexion or extension of the head by the use of the described forceps are smaller than the head. The new blades are designed to fit the head and all curves are cephalic curves. The blades auto-

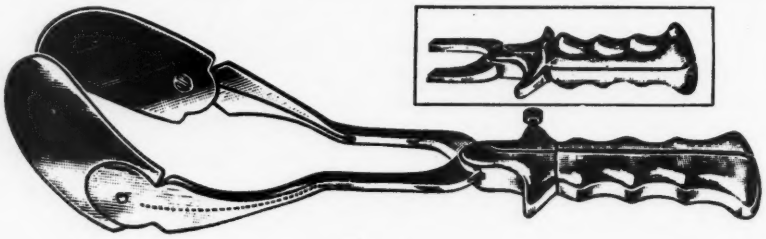

FIG. 1.

grip, thus enabling the replacement of natural labor powers by a forceps operation made to conform as closely as possible with natural conditions, and in a manner which might be considered entirely new.

The entire forceps is constructed as lightly as possible. This applies especially to the spoons, the thickness which is less than that of other forceps blades. This has been made possible by using solid blades.

The forceps has another advantage. It is especially equipped to manipulate one of the abnormal positions, occiput posterior position to occiput anterior position, or vice versa, when indicated. This is accomplished by rotating the head 180 degrees, if necessary, with one application. While this rotating movement is in progress, the blades automatically turn themselves to accommodate the new pelvic position, and also automatically adjust themselves to the pelvic curve. Delivery can be completed without removing or changing the first application of the forceps. De Lee,[4] using his own modification of Simpson's forceps, makes four different applications on the head to rotate 180 degrees.

A lock is provided in the shank to hold the forceps blades in a fixed position. This can be released by the operator after application of the forceps, thus allowing automatically free movement of the blades and the head during rotation and delivery.

It is unnecessary to provide blades with a pelvic curve in them since there is no pelvic curve in the head itself. There is no reason why the blades should be curved in the direction of the pelvic axis when they matically adjust themselves to the pelvic curve by the joint near the center, which assists the blades automatically to adjust themselves to the pelvic curve during the movement of rotating from the occiput posterior to occiput anterior position for delivery.

An obvious feature of the use of this new instrument is the fact that a second application of the forceps is not required during or after rotation has been completed.

CONCLUSIONS

The new forceps has the following advantages:

1. It is as easily applied as the Simpson forceps.

2. It is so constructed that when in place and locked, as traction is applied, the head is free to flex, extend or rotate to follow easily through the birth canal.

3. It facilitates the movement of the head along the longitudinal axis of the generative canal.

4. It reduces the pressure of the spoons to a minimum and equalizes the distribution of pressure in all parts of the birth canal during traction.

5. It eliminates the stiff bond between the head of the child and the hand of the physician since the head can extend, flex or swing as the pelvic curvature requires.

6. It is simply constructed, for safe manipulation and asepsis, but possesses axis traction advantages.

7. It requires but one application to rotate the head from an occiput posterior

position to an occiput anterior position (or vice versa), thus eliminating more chances of infection and trauma to mother and child.

8. It prevents the possibility of the head reverting back to its original position during the change of forceps.

9. The thumb screw on the right handle allows the operator to open or close the blades for a larger or smaller head.

10. The blades can be locked on the head by turning the outer handle right or left one-quarter turn.

11. The forceps blades can be locked in any desired pelvic curve before or during the application of the forceps. The locks can be easily released at the will of the operator.

The author wishes to express his gratitude to the following obstetricians who have accepted the new forceps for trial and given time and effort in the various stages of its development. Drs. Paul Titus, N. J. Eastman, John W. Harris, A. H. Lahmann, H. H. Cummings, J. B. DeLee, Fred L. Adair, William Dieckmann, R. M. Grier, William E. Caldwell, H. C. Maloy, Hugh J. Tunstead, A. B. Hunt, R. D. Mussey.

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A STRETCHER SPLINT FOR SAFELY TRANSPORTING THE INJURED

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VERY important and yet almost universally inadequately managed is the problem of transporting the injured from the site of accident to the place of treatment. The damage done in transporting these injured people cannot be accurately estimated, but without doubt is considerable. Many people lose their lives through well meant but unskilled handling after injuries to bones and joints.

The football player who injures his neck and is carried off the field without protection of the cervical cord is sometimes dead by the time he reaches the side lines. Simple fractures are often compounded and traumatic shock is multiplied by ineffective means of immobilizing and protecting the injured during transportation. Serious added insult too often occurs between the ambulance and the *x*-ray table or even on the *x*-ray table.

It was several experiences with badly injured skiers on the mountain slopes that made the author realize the importance of these problems, and that confronted by major fractures in a person requiring transportation, his M.D. degree and ordinary facilities made very inadequate splints.

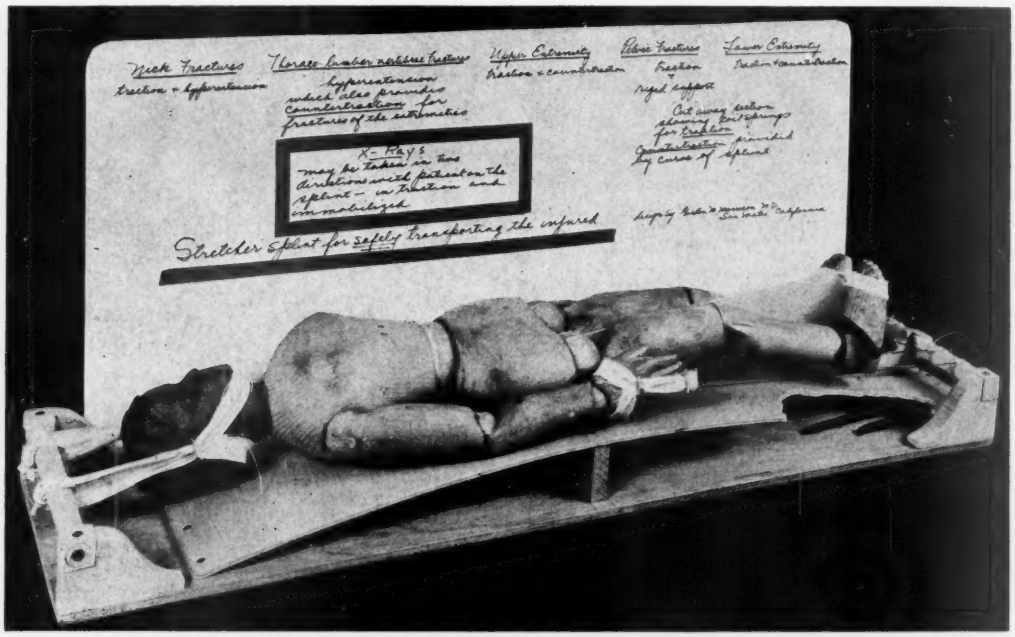

FIG. 1. Model of splint with wooden mannikin. Section cut away to show traction springs. Head sling is not necessary as dependent position supplies sufficient countertraction.

Present day equipment is far behind the present day accidents with their multiplicity of injuries and severe shocking power. The ordinary stretcher is helpful but inadequate, and when on extremely rare occasions a Thomas splint is available it is also helpful but in the hands of other than an expert may do harm and complicate handling. This equipment even if complete and available, as it very rarely is, provides little help in multiple injuries, and is especially inadequate in vertebral injuries.

In designing the stretcher splint here presented a hypothetical case of multiple injuries was considered, i.e., fractures of the vertebrae, pelvis, long bones of the arms and legs. The requisites for transporting each individual fracture problem were studied and a simple splint satisfying all requirements evolved.

A tabulation of these requirements follows:

1. *Vertebrae fractures and dislocations* (cervical, thoracic or lumbar): Immobilization with hyperextension, with or without traction.

2. *Pelvic fractures:* Rigid support with traction.

3. *Extremities* (long bones of arms and legs): Immobilization with traction and countertraction.

4. *X-rays:* Adequate two directional views should be possible without disturbing the patient.

5. *Multiple fractures:* These should be handled concurrently without extra equipment.

6. *Simplicity:* The apparatus should be "layman-proof."

All these requirements were found to be satisfied by the device.

The splint consists of a double plyboard frame about the size of a stretcher with the upper board gently arched and means of attaching traction to arms and legs.

The arched board provides hyperextension and thus gives protection for spinal injuries. This arch also provides a means of countertraction when traction is applied to ankles and wrists. Traction is made by long coil springs concealed between the boards which are so arranged that a pull of 10 pounds for legs and 5 pounds for arms is automatically obtained when the springs are attached to the extremities by Delbet knots or the Collins hitch.

It is also possible to apply head traction by using a chin occiput sling tied to the front of the splint. The splint can be placed on the *x*-ray table without disturbing the immobilization or traction and pictures taken by placing the films under or between the boards. A roentgenologist was consulted in designing this device and his enthusiastic approval was quite apparent.

FIG. 2. Stretcher showing the manner of attaching traction to arms and legs. The ropes lead from springs between the body of the stretcher.

Use of the splint requires no diagnostic ability on the part of the ambulance attendant and instructions are simple. The patient is placed on his back on the stretcher which, by virtue of moderate hyperextension, protects the spinal cord and provides countertraction for the limbs. The ankle straps are applied and traction and countertraction thereby obtained. Rotation is prevented by tying the boot to the center spline. If there is injury to the upper extremity, the wrists can also be fastened to the traction mechanism. Thus by placing the patient on this stretcher in a certain easily learned manner, practically any fracture is immobilized and put in adequate traction and countertraction. Transportation hazards are minimized, *x*-rays are taken without difficulty and the vital spinal cord is protected.

SUMMARY

A stretcher for transporting the injured is described which in an almost automatic

fashion immobilizes and places in controlled traction and countertraction any long bone fracture. At the same time vertebral fractures are placed in sufficient hypertension to protect the cord and prevent increase in deformity.

There is no necessity for the first aid crew to make a diagnosis as there is only one way to position the patient regardless of the injury.

X-rays may be taken without taking the patient out of the stretcher.

THE fundamental principle involved in the *treatment of fractures of the clavicle* is traction. In the absence of traction the pull of the pectoral and scapular muscles and the weight of the arm will drag the shoulder mesially and will cause overriding or upward or downward deformity of the fragments.

THE brief excerpts in this issue have been taken from "Minor Surgery" by Frederick Christopher (Saunders).

[From Fernelius' Universa Medicina, Geneva, 1679.]

BOOKSHELF BROWSING

THE HISTORY OF LINGUAL CANCER

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CANCER of the external parts of the body (skin, breast, external genitalia) is mentioned by the earliest medical writers, who recognized it as a definite disease entity. The first application of the term "cancer" (or rather the Greek "karkinoma") to malignant neoplasms is generally credited to the Hippocratic school, although this source is apocryphal. In any event, long usage of the term had already obscured its derivation by the time of Galen (A.D. 130–200), for he explained its probable origin by pointing out that "just as a crab's feet extend from every part of its body, so in this disease the veins are distended forming a similar figure." Paulus Aegineta (A.D. 625–690) commented further, "But some say cancer is so-called because it adheres like a crab." Medieval writers also referred to the origin of the term, and de Mondeville (A.D. 1260–1320) repeated these comparisons and added one of his own—that a cancer progresses "en rongeant" like the crab which walks backward and to the side as well as forward.

TONGUE CANCER IN THE MEDICAL LITERATURE PRIOR TO THE EIGHTEENTH CENTURY

The curious lack of specific mention of tongue cancer in the medical literature prior to the seventeenth century has already been noted by others. Certain portions of the Ebers Papyrus (about 1500 B.C.) have been interpreted as including directions for the treatment of "eating ulcer" of the gums and "illness of the tongue," which may refer to cancer. This document written in hieratic script is concerned mainly with therapeutics, and various diseases are listed (without further description) and their remedies prescribed. In the few significant medical writings of the first thousand years of the Christian era, cancer in general is frequently, though rather vaguely, mentioned, but there is no direct reference to this disease as affecting the tongue. So far as is known, the first definite published report of a case of lingual cancer was made by an Englishman, Alexander Reade, in 1635.

At first glance it may seem remarkable that there should be so little mention of lingual cancer in the early medical literature, since today cancer of the tongue makes up between 2 and 3 per cent of all human cancer and is responsible for about 1 to 2 per cent of all cancer deaths. Butlin, among other writers, interpreted this negative historic evidence as indicating that cancer of the tongue was relatively rare until the beginning of the seventeenth century. D'Arcy Power, who was of a

similar opinion, commented that the characteristic symptoms of lingual cancer, and especially those of its late complications, would have insured its more frequent recognition had the disease been as common then as it is now. These and other writers have pointed out that several of the etiologic factors which are known to be of importance in the causation of present day tongue cancer appeared in Europe during the fifteenth and sixteenth centuries; namely, syphilis, tobacco, and distilled spirits (and there might also be included the habitual use of hot beverages such as coffee and tea). Although there may be considerable merit in these interpretations, nevertheless there appears to be more historic mention of cancer of the tongue than is generally believed. Furthermore, many of the ancient references to diseases of the tongue undoubtedly allude to cancer although this disease is not specifically named.

There can be little doubt that Hippocrates (B.C. 460–370), in his *Prorrheticon* refers to tongue cancer when he states that chronic ulcers of the tongue are common at the edge and urges that an examination be made for the presence of sharp teeth in contact with such ulcers. This injunction was copied almost verbatim by the encyclopedist, Celsus (fl. A.D. 178), when he observed that ulcers which arise at the side of the tongue last the longest, "and it must be looked to whether some tooth opposite the ulcer is too pointed, in which case the tooth must be smoothed down." During the next sixteen centuries, comments regarding the tendency to long duration of ulcers occurring on the edge of the tongue and their probable origin from contact with sharp teeth appear so often as to suggest plagiarism from these original statements as well as personal observations (Lanfranc, Paré, Riverius, Bell, Gibson, Walshe, Pemberton, Home, Wilson).

Galen makes no specific reference to cancer of the tongue, but he mentions "tumores duri" (hard tumors) among the organic diseases of the tongue which he will discuss in a later book, apparently not now extant.

While it is certainly true that many of the medical writers of the first thousand years A.D. make no reference to tongue cancer, nevertheless on carefully perusing the whole texts of these medical writings, one is impressed with the fact that the lack of more specific mention of this form of the disease is in keeping with the rather vague and abstract descriptions of cancer elsewhere in the body and, as a matter of fact, of all other diseases. Aretaeus (fl. A.D. 100) does not mention cancer at all. Orebasius (A.D. 326–405) refers only to cancer of the pudenda, testes, and breasts. Rufus, in commenting on the writings of Orebasius, refers to the various forms of cancer which occur throughout the body, but omits the tongue. Paulus Aegineta (A.D. 625–680) merely states that cancer occurs in every part of the body, but most frequently in the breasts of women. It is fair to assume, therefore, that none of the latter four writers had observed a case of cancer of the tongue.

The field is not entirely barren, however, for Avicenna (A.D. 980–1037) in his *Canon of Medicine* mentions "apostema dura" (hard sore) of the tongue, which undoubtedly alludes to cancer. Abulcasis (A.D. 1013–1107) and Guy de Chauliac (d. A.D. 1368) mention cancer of the tongue briefly in passing. Ambrose Paré (A.D. 1517–1590), in a passage reminiscent of Hippocrates and Celsus, is quoted as stating that "ulcers of the tongue may be cured by the same remedies as the rest of the mouth, yet ulcers which breed on the side of the tongue endure very long," and "you must look whether or not there be some sharp tooth over against it which will not suffer the ulcer to heal, and if there be, then you must take it away with a file."

Riverius (A.D. 1589–1655) in his *Practice of Physicke* may be describing a cancer when he speaks of a case of ulcer of the tongue "which proceeded from the grating of the teeth whereupon it rested." His mention of "cancerous swelling" of the

tongue which is "known by its hardness, blueness, and pricking pain" may be taken as an example of the confusion in the diagnosis of this disease which becomes so apparent in the following two centuries.

Theophile Bonet (fl. A.D. 1684) apparently recognized that cancer occurred in the tongue, for in describing the treatment of ranula, he recommended that certain precautions be taken so as not to "endanger a cancer."

Other writers of this period who make no mention of cancer of the tongue apparently had very little experience with this disease in any part of the body. John of Vigo does not mention cancer at all. De Mondeville, although he writes at great length of the varieties and causes, the symptoms and treatment of growths in such general regions as the upper and lower extremities and upper air passages, discusses no specific anatomic form of cancer except that of the breast. In his *Select Medicinal Counsels* (1678) Fernelius' only mention of the subject is of two tumors in the left armpit which "have the show of certain cancerous wenns." In his autobiography, Master Johann Dietz (1665–1738), a licensed barber and surgeon, makes no mention of cancer in any form, although he writes extensively of his professional activities. It is worthy of note that in many of the later writings where cancer of the tongue is specified, the references appear to be so casual as to give the impression that the writers considered the occurrence of this disease in the tongue in no way remarkable.

INTERPRETATION OF HISTORIC DATA

Although the foregoing list does not pretend to be complete, it is certainly significant that about half of these ancient writers make observations which can logically be interpreted as referring to cancer of the tongue, despite the fact that at least a third of them do not mention cancer at all. From present day knowledge, one may speculate with a considerable degree of accuracy as to which of the many tongue lesions described were probably cancer.

Only the most incredulous skeptic will doubt that the terms "tumores duri" and "apostema dura," as employed by Galen and Avicenna, refer only to cancer. There are other somewhat ambiguous references which include chronic ulcers, ulcers which arise on the edge of the tongue, and corrosive ulcers. If we assume that the diseases to which man is now subject have not markedly changed in their nature, symptoms, and clinical course since that period, the most common chronic ulcers of the tongue would have been (as they are now), in the order of their frequency, cancer, tuberculosis, and syphilis. The other more acute and painful ulcers of the tongue of shorter duration (traumatic, herpatic, and simple inflammatory), being self-limited, would have caused little concern either to the physician or to the patient. It would surely be illogical to assume that tuberculosis and syphilis, rather than cancer, were the most common causes of these hard chronic ulcers and tumors of the tongue so often mentioned in the early literature. Moreover, the repeated reference to the teeth as an inciting cause of these lesions is further evidence of their probable malignant character, for cancer of the tongue, arising at its most common site in the middle third of the lateral border, would have suggested then, as it does now to both the patient and the physician, an origin from dental trauma.

The shorter life expectancy in the early Christian and medieval eras as compared to the modern would also undoubtedly influence the incidence of cancer, which is mainly a disease of late middle and old age. The average length of life in the first few centuries A.D. ranged from twenty to thirty years, and by the eighteenth century in Europe had increased only to forty years. Today the life expectancy of white males in the United States at birth is fifty-nine years. In a recent study of about 550 consecutive cases of tongue cancer at the Memorial Hospital in New York, it was

found that the average age of the patients was 58 and that only 3 per cent of the cases occurred in patients below the age of 39. Under these conditions, a relatively small percentage of people could have lived into the cancer age during the early Christian and medieval eras and, therefore, as compared to the present, the actual number of lingual cancers may have been small. It is entirely possible, however, that in these early periods cancer of the tongue occurred among people 58 years of age about as frequently as it does today.

At the present time, cancer of the tongue and of the lip have about an equal incidence. It should therefore be significant that except for two or three isolated references to cancer of the lip and of the tonsil, lingual cancer is the only intraoral form of this disease specifically mentioned in these early writings. In the final analysis, the infrequent historic mention of tongue cancer should probably not be interpreted as indicating so rare an incidence as has been suggested by many writers.

INFLUENCE OF RELIGIOUS SUPERSTITIONS

From earliest times, the tongue has been associated in the public mind with the production of speech. Until the modern era, therefore, any affliction of this organ, with the attendant speech disability, was likely to be ascribed to divine punishment for such heinous crimes as heresy, blasphemy, or clerical lèse majesté.* These practices and superstitions would naturally contribute to the failure to record many of the tongue disabilities which did occur as the result of natural disease phenomena.

In 1672, Paul de Sorbate of Germany published a case report, that of Baron Vertemali, who, it is related, recognized with great penitence shortly before his death "that the cause of his cancer (of the tongue) was divine punishment because he so often abused the clergy." Bonet (1620–1689) also comments on the supernatural significance of this case. Such a superstition is also apparent in the case of Nestorius (fl. A.D. 430), a Syrian bishop who promulgated the doctrine of monophysm (the single as opposed to the dual nature of Christ). His enemies triumphantly related that his tongue was eaten by worms as a divine punishment for his heresy. History does not record how the learned doctors of divinity finally came to agreement concerning the number of Christ's natures, but it is not unreasonable to suppose that among Nestorius' attending physicians there may have been at least one skeptic who, too prudent perhaps to risk excommunication by voicing his opinions, nevertheless suspected (as, no doubt,

* As the result of such beliefs, excision of the tongue was the penalty often considered suitable for those who dissented from the established religious opinion. This mutilation was intended to prevent any further utterance of heresy. The executioner drew the tongue from the mouth, usually by a sharp hook, and cut off the protruding portion from below upward. Sometimes the first step in excision was to nail the tip of the tongue to a tree.

The most famous case is that of the sixty Christian confessors of Tipasa whose tongues were excised by order of the Vandal king, Hunneric, in 484 A.D. Immediately after the operation it was noted that many of these martyrs were able to speak, and a controversy arose which raged for centuries concerning the supposedly miraculous return of the power of speech. Victor, an African bishop, wrote a report of the event within two years after its occurrence. Procopius of Caesarea saw some of the victims years later and, in support of the miracle theory, reported that the tongues were cut out "as low down as the throat," but that with the exception of two who had "allowed themselves to hold converse with abandoned women" and therefore "ceased to speak," none showed any effects of his punishment. Twistleton, in an admitted attempt to discount the "miraculous element in the history of the African confessors," gathered together a series of cases of individuals who had lost their tongues by disease or excision, or who had been born without them, and who were still able to speak. Among these were a group of French Protestants who were condemned to have their tongues out before being led to the stake. Immediately after the operation one of them repeated three times, "Le nom de Dieu soit beni." It is a well known fact today that after excision of the tongue as far back as the anterior tonsillar pillars, the remaining stump and the musculature of the floor of the mouth develop an unusual range of motion, so that the functions of the tongue in articulation and in swallowing are retained to a surprising degree. Brodie, furthermore, pointed out that the early executioners, in general, removed a much smaller portion of the tongue than they thought. In any event, it is highly probable that the recoveries from these early excisions of the tongue paved the way for early attempts at glossectomy in the treatment of diseases of the tongue.

does the reader) that the unfortunate churchman died of tongue cancer.

CONFUSION IN DIAGNOSIS*

During the eighteenth century, one finds numerous references and reports of operations on lingual tumors, many of which were obviously not cancer. It was not until the time of Virchow (1821–1902) that definite attempts were made to distinguish clinically between gumma and cancer of the tongue. At about the same time, Anger (1872) called attention to the frequency with which these two lesions were confused. He stated that the natural progression of lingual cancer under antiluetic treatment was often erroneously ascribed to mercurial glossitis, so that all treatment was stopped to await the subsidence of this supposed complication while the cancer was left, undiagnosed and undisturbed, to pursue its natural malignant course.

A lesion occasionally confused with carcinoma was lymphangioma, which was probably the case in the celebrated operation done by Louis in 1759 "d'un seul coup de ciseaux," and sometimes referred to as the first case of tongue cancer operated upon. Lymphangioma also appears to be the most likely diagnosis in some of the cases reported by Home and Inglis. An error in diagnosis, even more obvious, is the second case mentioned by Louis and cited by many others, that of a girl of 20 years of age who "had lost her tongue at the age of 4 by cancer." The literature contains several references to children whose tongues became gangrenous and sloughed away as the result of smallpox, and it is possible that this girl was the victim of such a disease.

Up until the latter part of the nineteenth century, most cervical lymphadenopathies were apparently grouped under the general term "scrofula," especially if they were associated with "eruptions" of the skin or oral mucous membranes. Under such conditions it is obvious that errors in diagnosis would be likely to occur in the cases of oral cancer in which cervical lymphadenopathy appeared as the first or as one of the early symptoms. In these cases, the small primary lesion of cancer, either in the skin or in the mucous membrane, was probably often classified as an "eruption" and the metastatic cervical node diagnosed as "scrofulous."

INTRODUCTION OF NEW ETIOLOGIC FACTORS

If one depended entirely upon the number of cases reported in the literature for proof of the incidence of tongue cancer, one would be forced to conclude that there was a definite increase in the occurrence of this disease about the seventeenth century. The possible relationship between an apparent increase in lingual cancer and the introduction of new and competent etiologic factors at this time has been made the subject of considerable speculation. Curiously enough, there is indisputable evidence that several such factors were introduced or became prevalent during this period; namely, syphilis, tobacco, and certain dietary changes.

At the present time, more than one-third of all patients with tongue cancer also have syphilis, a fact which indicates a highly significant causal relationship. Whether or not one subscribes to the theory of pre-Columbian syphilis in Europe, it is a well attested historic fact that this disease became epidemic on the Continent during the fifteenth and sixteenth centuries to such an extent that a large percentage of the general population was afflicted. It follows, therefore, that

* Much of this confusion in diagnosis was due to a lack of uniform terminology, so that many diseases were considered to be similar to but not identical with cancer. Walshe, in 1857, in an attempt at systematization, divided all cancer into three classes; namely, colloid or jelly-like cancer, scirrhous or hard cancer, and encephaloid or soft cancer. Under these "species" he listed thirteen "varieties." In connection with his classification of cancer, Walshe mentioned thirty-three "synonyms" (as, for example, struma fungosa, fungus haematodes, cerebroform degeneration, milk-like tumor, galactomyces, scirrhoma, etc.) of the "species" of cancer, which he condemns as being a "diversity of names" which "by no means implies a corresponding diversity of things."

there must have been a marked increase in syphilitic glossitis, a form of chronic irritation which today is the most important single etiologic factor in the production of lingual cancer.

Another form of chronic irritation universally considered important in the present day etiology of tongue cancer is tobacco, the use of which was introduced into England from America in 1586. The habit became widespread on the Continent in the following century. References to the association of pipe smoking with cancer of the tongue and of the lip have been so long and so frequently made as to become classical and, as with certain other conventional beliefs, their importance has probably been exaggerated. In any event, the influence of tobacco in lingual cancer today is probably often overemphasized, especially with regard to cigarettes or the moderate indulgence in other forms. The percentage of patients with tongue cancer who use tobacco is of little significance from an etiologic standpoint unless this figure is compared with the percentage of addiction in the normal healthy adults.

The habitual consumption of beverages of high alcoholic content is sometimes considered competent to produce lingual or other forms of intraoral cancer. It is believed that about 800–900 A.D. the Arabs brought to perfection the art of distillation, although they themselves may not have invented it. The word "alcohol" was coined by them. It is not definitely known when the use of this more potent liquor became common, but during the reign of Elizabeth (1558–1603), a tax was first placed upon distilled alcoholic beverages. One might be justified in supposing that the first levy of such a tax followed a marked increase in the use of these distillates, for it is obvious that an alert financial adviser of the good queen would have been quick to take advantage of any new and profitable source of revenue. The alcoholic content of the fermented beverages used before the introduction of distillation could probably have no marked irritating effect upon the tongue, but there is no doubt that the habitual use of liquors containing 40 to 50 per cent alcohol (whiskey and brandy) can produce such an effect on the oral mucous membranes.

In the sixteenth and seventeenth centuries, coffee and tea were introduced into Europe, and though at first they were very expensive, their use soon became widespread. These were probably the first very hot beverages to be habitually consumed by man, and it is reasonable to believe that such a thermal irritant to the oral cavity repeated several times daily over a period of years might exert a definite carcinogenic action. Another dietary factor which probably became significant during the Middle Ages was the excessive use of highly flavored sauces and condiments made from spices, which were held in great favor to disguise the otherwise unpalatable and monotonous flavor of the poorly cooked and often poorly preserved meat which comprised the main article of diet. It was because the trade in spices was so profitable that Columbus set out to find a short route to India. The excessive use of such undoubtedly irritating condiments, as well as very hot food and drink, is frequently noted in patients with marked leucoplakia and sometimes with cancer. In all of these cases, however, it is not entirely clear that the inordinate desire for highly seasoned or hot foods has actually preceded and probably caused the development of leucoplakia. Lacking specific observations as to the previous condition of the tongue, it is almost equally possible that these abnormal cravings result from an instinctive effort to titillate the diminished gustatory sensations of the relatively insensitive leucoplakic tongue surface.

It is an undoubted fact that a more frequent reference to tongue cancer in the medical literature began late in the renaissance, coincident with the introduction of these several etiologic factors. From the available evidence, however, it is

difficult to assay their significance as compared with the more frequent recording of tongue cancer which would naturally grow out of the awakening of interest in science accompanying the renaissance, and the steadily increasing life expectancy. Astute medical observers are well aware of the fact that the apparent incidence of a given disease from time to time often varies directly with the interest manifested in it by the medical profession. Therefore, that the early physicians did not often mention tongue cancer does not necessarily indicate that the disease was unusually rare as compared to the present time.*

DEVELOPMENT OF TREATMENT METHODS

Beginning with Hippocrates and continuing until the sixteenth century, cancer of the tongue was considered a *noli me tangere*. Abulcasis (A.D. 1013–1107), who noted the occurrence of several varieties of "tumors" in the mouth and throat, describes the use of the cautery for treating external cancer, and warns that in the treatment of ranula, one must be certain that the tumor is neither "livid and black" nor "hard and painless," for "if it is, do not touch it, it is cancer." Guy de Chauliac (d. A.D. 1368) speaks of corrosive ulcers in the tongue and states that "if the growth in the tongue is hard and cancerous, don't touch it to cure it." Lanfranc (fl. A.D. 1490) was probably speaking from an unpleasant personal experience with a case of lingual cancer when he advised that "if an ulcer (of the tongue) be melancholic, which you know by the livid or black color, don't touch it."

* A questionnaire was recently sent by the author to ten general practitioners without hospital connections who have practiced in rural communities for periods of twenty-five to forty years. About half of these physicians stated that they had never observed a single case of cancer of the tongue in their own practices, and only one had observed more than two cases. Certainly the rural general practitioners of today are far superior to ancient and medieval physicians by virtue of training and cumulative experience, and since they rarely encounter lingual cancer, it seems irrelevant to the study of the comparative incidence that so many of the earlier medical writers fail to mention it.

Early Attempts at Glossectomy. By the beginning of the eighteenth century, there had already been several attempts at surgical removal of lingual tumors. Marchetti in 1664, using the cautery, was probably the first to attempt the extirpation of cancer of the tongue. In 1676, Wiseman reported operating upon two patients with cancer of the tongue, using the cautery, both of whom later died with metastases. Following these two glossectomies, the use of the cautery in the treatment of lingual cancer seems to have fallen into disrepute, and it was not until the beginning of the twentieth century that it came again into general use. Today it is considered one of the most practical methods.

Gemy in 1787 reported the postoperative recovery of a patient following the removal of a carcinomatous tumor from the side of the tongue, but Richard in 1852 made the statement that there was at that time no authentic case of cure of cancer of the tongue in all the literature. Pemberton in 1867 concurred in Richard's statement with the comment, "there are no remedies with which we are at present acquainted that exercise any influence in retarding the progress of this disease. . . . Our only means of arresting the progress of cancer of the tongue consists in resorting to an operation. Under the best aspects the treatment of cancer of the tongue by operation can be looked on only as a palliative measure, the tendency after all operative interference, however well considered, being to a speedy relapse."

The difficulties attendant upon the early attempts at surgical removal of the tongue can well be appreciated, and the operation seems always to have challenged the efforts of the more courageous surgeons. Louis, in his plea for earlier and more frequent performance of glossectomy when indicated, chides Morgagni for advising against the operation, and states that "il n'est pas exercé par des hommes timides." Harris, in 1720, recognized the danger accompanying excision of the

tongue, but nevertheless seemed to feel that perhaps the operation might at least have some psychotherapeutic merit for he observed philosophically that "if anyone is exceedingly wearied with such tumors (of the tongue), and especially dejected in mind, whilst he is prepared to bear equably whatever may happen, he should not be denied the trial of the operation of excision." Clarke (1873), in the same vein, said of the operation that "though it may only be temporary, relief is given both to the body and mind of the sufferer."

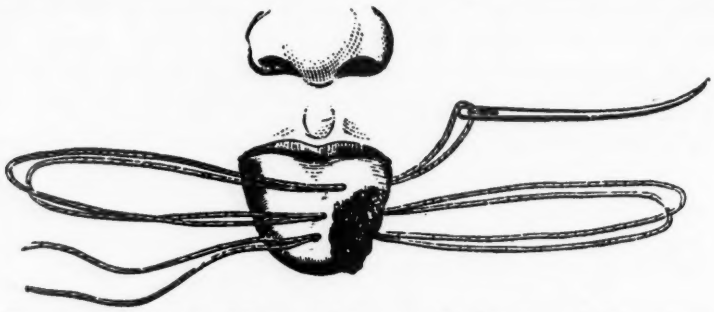

Fig. 1. Application of ligature for removal of cancer of the tongue (Erichsen). By cutting off the needle and cutting through the loops, the ligatures could be tied separately so as to encompass the entire diseased portion which, according to reports, sloughed off eight to ten days later.

Although hemorrhage is not often specifically mentioned in the earlier reports of surgical excision of the tongue, it is probable that this complication was the main cause of the timidity of which Louis accused Morgagni. When hemorrhage was controlled by packing and the application of caustics or "tincture of iron" ($FeCl_2$), local oral sepsis figured as a prominent complication and was frequently followed by pneumonia. Butlin in his first edition discusses at some length the dangers of these early operations with their troublesome and frequently fatal pulmonary complications. He believed that "the pneumonia is due, in a large majority of instances, to the inhalation of foul gases from the decomposing wound." The Mirault, in 1813, introduced the ligation of the lingual artery before they removed a "fungating ulcer" from the tongue of a man, but Roux, in 1839, was the first to describe the removal of an undoubted epithelioma preceded by the ligation of the lingual artery. Robert, in 1856, recorded two cases in which severe hemorrhage following excision of the tongue was controlled by applying the handle of a spoon to compress the tongue, in the same manner as when examining a sore throat.

Beginning with Louis, the surgical aspect of glossectomy for a variety of conditions, including cancer, was emphasized rather than the clinical features of the disease, so that little progress in the study of lingual cancer was made until the time of Anger in 1872 and Butlin in 1885, both of whom published monumental works on this disease. Butlin's historic interest in lingual cancer seems in the main to have followed the surgical development of glossectomy. In his later editions, the historic details of the evolution of this procedure are rather extensively recorded.

Glossectomy by Ligature. At about the beginning of the nineteenth century, operations upon the tongue became more extensive than they had been previously, and postoperative hemorrhage, both immediate and late, called for some other method of excision than by scalpel. The slow strangulation and necrosis of the part by several ligatures encompassing the tumor area was one means introduced to prevent immediate hemorrhage. Home is believed to be the first to use this method, and in 1805 he reported six cases of his own or of others, five of which were probably cancer.

The technique of this procedure as described by Home was to draw the tip of the tongue from the mouth and pierce it from its superior to the inferior surface with a needle threaded with a double ligature. (Fig. 1.) The needle was then cut off, one ligature tied in the sagittal and one in the coronal plane over the surface of the tongue so as to strangulate a wedge-shaped area containing the tumor. The operation was, of course, performed without anesthesia, but after the ligatures were tied the patient was usually given tincture of opium. If the ligatures were tight enough, the strangulated portion soon became necrotic and slough separated within seven to nine days. Hilton and, later, Moore recommended division of the lingual nerve as the first step in the operation, as well as for the palliative relief of pain.

Inglis in 1805 reported the removal of two supposed cancers of the tongue by ligature. From the clinical descriptions, the long duration, and the presence of one in a girl of 10 years of age, one is led to the conclusion that both were probably lymphangioma. Cloquet, in 1827, applied the ligature from below, introducing it under the mandible through incisions or stab wounds in the submaxillary or suprahyoid regions in such a way as to encircle the base of the tongue. Mirault in 1833 placed a mass ligature deeply in the floor of the mouth in an attempt to ligate the lingual arteries prior to glossectomy. Despite some immediate technical difficulties and the subsequent failure of one of the ligatures to hold, Mirault reported that "la tumeur s'atrophia et disparut entièrement."

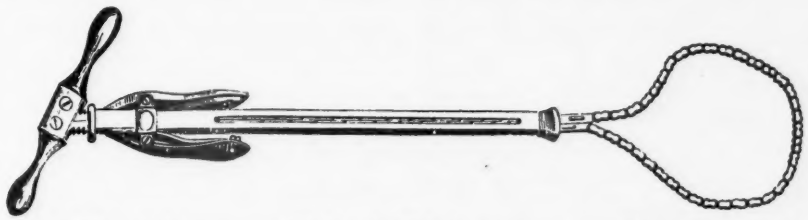

Fig. 2. The chain ecraseur (Holmes). This instrument, an elaboration of the principle of the ligature, used either a cord, a wire, or a chain which could be drawn tight by means of a screw, and provided for the more rapid strangulation and cutting through of the diseased portion of the tongue. (See Figs. 4 and 5.)

The Ecraseur. The plain ligature method was sometimes uncertain in its application, and in any event required several days for the separation of the strangulated portion, so that about the middle of the nineteenth century the ecraseur (crusher), an elaboration of the same principle, was introduced by Bell. By this method the operation could be completed in a much shorter time. This instrument, in the words of Clarke, consisted "of a chain or wire disposed in the form of a running loop at the end of a shaft. This shaft is provided with a suitable handle and with a powerful screw, by means of which the loop can be drawn tight." (Fig. 2.) The part of the tongue to

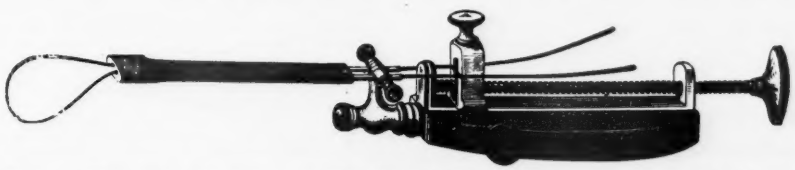

Fig. 3. The galvanic ecraseur (Erichsen). In this instrument the wire loop was heated by an electric battery, thereby combining the cautery with a crushing action. Judging from the rather infrequent mention of the instrument, it is probable that its use was more theoretical than practical.

be removed was encircled by the loop, and by gradually increasing the tension a part of the organ was strangulated and cut

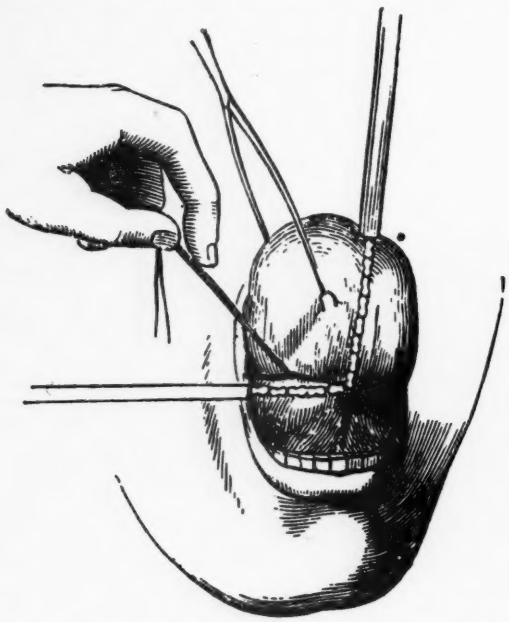

Fig. 4. Removal of the anterior portion of the tongue by the application of two ecraseurs (Erichsen). The ligature in this case was used both for traction and to prevent the ecraseurs from slipping forward.

through, thereby supposedly preventing any serious hemorrhage. Chaussaignac described an elaborate technique by which the chain was introduced through stab wounds at the upper point between the submental and suprahyoid regions so as to encircle the whole tongue proximal to the tumor.

Boyer stated that with this device it was possible to remove the anterior portion of the tongue, the whole, the lateral half, or any tumor which developed on the superior or inferior surfaces in the angle formed by the base of the tongue and the floor of the mouth, although he did not cite any cases of his own. Middeldorpff, by the use of a galvanic battery (Fig. 3), heated the loop of such a chain, thereby combining the advantages of the cautery with the crushing action of the ecraseur. Barwell developed an operation for excision of the tongue using two ecraseurs with soft iron wires. He specified that "the wire I use is a strand of wire rope used for park fencing." (Fig. 4.)

Baker modified the ecraseur method by

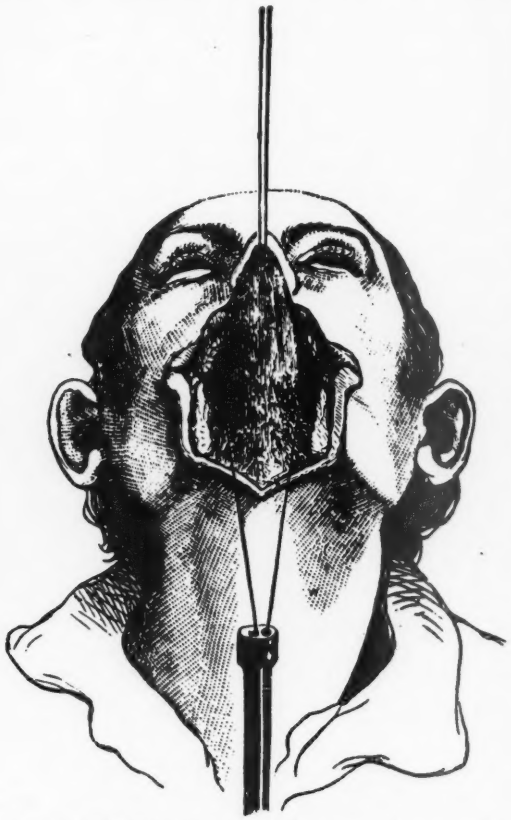

Fig. 5. Sedillot's approach for operations on the tongue by splitting the lower lip and jaw in the midline (Erichsen). The tongue was drawn forward and the anterior portion removed by a wire ecraseur.

using whipcord rather than chain or wire for the noose, after preliminary freeing of the tongue from its attachment to the genial tubercles and from the anterior tonsillar pillars. In order to obtain more space, he sometimes divided the cheek as in Jaeger's operation. The noose was placed behind needles thrust into the tongue well back of the diseased portion, in order to prevent its slipping forward over the growth. One cannot but be impressed by the fortitude of those patients who submitted to ordeals so protracted and painful before the beneficent discovery of general anesthesia.

Escharotics. Although escharotics had long been used for external cancer, it remained for Girouard in 1857 to apply

such substances to tongue cancer. He introduced pieces of zinc chloride into stab wounds surrounding the tumor and claimed good results in several cases. Maisonneuve in 1858 also recommended this procedure. Arnott in 1858 reported a case of tongue cancer treated by injections of acetic acid in water, supplemented with surface applications of undiluted acid. At the end of a month "scarcely any hard base existed, but it has extended toward the tip of the tongue." In 1861 Bright recorded a case of lingual cancer treated successfully by repeated applications of copper nitrate. Clarke, however, in 1873 reported that caustics were no longer in general use for treating cancer of the tongue.

Introduction of Systematic Excision. Beginning with Langenbeck who, in 1819, introduced the V-shaped excision and closure, surgical excision by the scalpel developed coincident with the continued use of the ligature, ecraseur, and escharotics. In 1831, Jaeger divided the cheek to obtain better access to the tongue before excising it, and Roux (d. 1836) and Sedillot (1844) divided the lower lip and the lower jaw itself, for the same purpose. (Fig. 5.) Regnoli (1839) opened the floor of the mouth from below by a curved incision from the middle of the hyoid bone to the chin, and the tongue was then drawn through this opening for its excision. (Fig. 6.) Billroth, Kocher and von Langenbeck, during the latter part of the nineteenth century, also developed approaches through the submaxillary and suprahyoid regions, and these early pharyngotomies still survive in the present day laryngopharyngotomy of Trotter and of Hofer and Hajek. Unless the latter ambitiously conceived procedures be taken as heralding an even more radical era for the surgical treatment of lingual cancer, the zenith of radical surgery for cancer of the tongue was reached in the late nineteenth century with the perfection of the technique of general anesthesia and of aseptic surgery.

Clarke, in 1873, advised against the use of a general anesthetic in glossectomy performed with a scalpel, but Whitehead (1881), with the assistance of chloroform anesthesia, systematized the operation

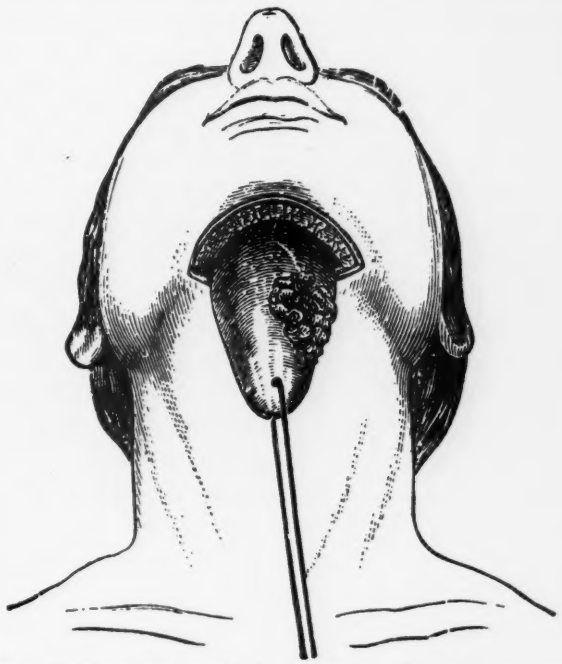

Fig. 6. Regnoli's method of exposure for glossectomy (Erichsen). A curved incision was made in the submental region along the inner border of the mandible and through the floor of the mouth. The tongue was then drawn through this opening for excision. The particular advantages of this approach are not entirely clear, and were probably mainly theoretical.

done through the open mouth without splitting either the cheek or the jaw. By careful attention to anatomic details, this operation was unusually successful for that period and employed none of the crude and deforming procedures previously recommended. Butlin, from 1881 to 1908, operated upon 197 patients with cancer of the tongue, and fifty-five of them lived from three to twenty-two years without recurrence.

Radiation Methods. Shortly before the turn of the nineteenth century, two new agents were discovered which later came to play a most important rôle in the treatment of cancer. Roentgen, in 1895, discovered *x*-rays, and two years later the Curies discovered radium. It was not long until the curative effects on cancer of both *x*-ray and radium had been demonstrated.

In 1902, Beck mentioned cancer of the tongue as being suitable for treatment by *x*-rays, and in the same year Cleaves suggested the use of an *x*-ray tube with a target in a tubular projection which could be inserted into cavities, as for example in the treatment of cancer of the mouth, rectum, cervix and vagina. This idea was soon abandoned because of the difficulty of insulation which resulted in burns of several patients, but Cleaves' original suggestion has been developed more recently by Chaoul.

A more detailed report of *x*-ray therapy in cancer of the tongue was published in 1902 by Dickson, who had treated one case by daily divided doses over a period of three weeks, through the open mouth, shielding cheek and lips. Pratt, in discussing Dickson's paper, reported a case of lingual cancer treated with *x*-ray, using a celluloid speculum to hold the lips apart.

In 1903, Engman reported a case of lingual cancer also treated by daily divided doses of *x*-ray, the first series over a period of thirteen days, the second over a period of eight days, with a week's interval between. The treatment produced a mucositis, and within a month the tongue was practically healed. A year later the patient was well. Krauss, also in 1903, treated cancer of the tongue with *x*-ray. In 1904, Bulkley treated two cases with radium, and Courtin and Bergonne treated one case. Hallopean, in the same year, reported similar treatment of two cases.

In February, 1902, *x*-radiation for the treatment of cancer was first used in the Memorial Hospital, New York City (then called the General Memorial Hospital). In the report of that hospital for the following year, Dr. William B. Coley stated that eighty-four cases of various forms of tumor had been treated, and adds that "in the tongue cases, there have been no good results," although he does not mention the number of cases treated. Not until 1911 do the yearly reports of this hospital again mention the use of radiation in the treatment of cancer.

Dominici, in 1908, reported a case of tongue cancer successfully treated by the application of radium contained in lead tubes. He stated that the treatment was successful in only one case in which the cancer had not gone beyond the mucous membrane of the tongue to penetrate the muscular tissue. In 1909, Forssell of Stockholm began the treatment of tongue cancer by radium.

Stevenson, in 1914, appears to have been the first to employ needles containing radon or radium for interstitial use, and in 1915 he reported success with twenty-two cases of cancer, including three in the tongue. Shortly thereafter, this method was put into use at the Curie Institute by Regaud and at the Radiumhemmet by Forssell and Berven. In both of these institutions, radium element needles are still considered the most suitable interstitial applicators for the treatment of lingual cancer.

In 1917, Janeway reported the treatment by radium of forty-eight patients with cancer of the tongue at the Memorial Hospital, the first one on August 28, 1914. Radon capsules attached to the tongue by means of barbed hooks were used in treating the first cases. These devices were soon found to be unsatisfactory, and were replaced by platinum tubes of radon tied or sewed to cotton cloth and held in place upon the tumor by gauze packing. Janeway found it difficult to maintain any of these devices in accurate approximation to the tumor. In some instances, he insisted that the patient hold out his tongue during the entire treatment, which often extended over several hours. A nurse was on duty beside the patient throughout the application to give moral support during the ordeal, and to make certain the applicator remained in proper position.

In the 1917 Radium Report, Janeway refers to Duane's suggestion for the construction of very fine short glass tubules for interstitial insertion, but the so-called "bare tubes," or glass seeds, did not come into use until 1918. From that time on,

they were employed by Janeway and Quick in the treatment of tongue cancer. A review of Janeway's case reports indicates that with his method of radium treatment of early tongue cancer by contact application, surface healing of the tumor was often followed by recurrence. He seemed to be particularly impressed by the fact that such recurrences were likely to take place on the borders of the lesion, and discussed the advisability of treating an area larger than the apparent size of the tumor itself. His difficulties are illustrated by his statement (in 1917) that "by the time cancer of the tongue becomes over one centimeter in diameter, the possibility of healing it with radium becomes uncertain."

About 1920, the endotherm knife was developed on the basis of DeForrest's earlier discoveries that a rapidly oscillating electric current would cut. This device has been favored at times by Wyeth and others almost to the exclusion of other agents in the treatment of intraoral and accessible cancer.

At the time of this writing, radon gold seeds or radium needles of small caliber and content are the most widely used form of applicators for interstitial radiation, and are often combined with surgical removal by cautery or endothermy for the treatment of the primary lesion of tongue cancer. The most recent development in the treatment of intraoral cancer is the reintroduction of peroral *x*-radiation employed in conjunction with one or more of the above-mentioned methods.

SUMMARY AND CONCLUSIONS

Cancer of the tongue is almost the only form of intraoral cancer which is even vaguely mentioned in the early medical writings, and most of these early references are by inference only. So far as is known, the first definite case report of lingual cancer appeared in the medical literature in 1635. Subsequent case reports and clinical descriptions of this disease were made with increasing frequency during the next two centuries, coincident with the introduction of certain new etiologic factors competent to produce irritation in the tongue. The question might be raised, therefore, whether the introduction of these several new etiologic factors was the direct cause of an actual increase in lingual cancer or whether they were simply coincident with a more frequent reporting of the disease during the scientific awakening of the renaissance.

Surgical excision of the tongue was introduced in the seventeenth century, but undoubtedly many lesions operated upon were not cancer. These first attempts at glossectomy for a variety of diseases were probably suggested by the recovery, often considered miraculous, following excision of the tongue as punishment. The early operations for cancer were accompanied by several serious complications, and during the nineteenth century several new methods and modifications were devised to obviate these complications, including the use of the ligature, the cautery, the ecraseur, escharotics, ligation of the arterial blood supply and, finally, toward the close of the nineteenth century, the application of radium and *x*-ray.

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